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23rd ANNUAL SCIENTIFIC and CLINICAL SESSION

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ORIGINAL ARTICLES

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EDITOR OF THE MONTH

RICHARD KOVACS, M.D.

New York, N. Y.

Printed in U. S. A.

MODERN HYDROTHERAPY
A REVIEW OF RECENT DEVELOPMENTS *

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Ten years have passed since the hydrotherapy department of the Hospital for Joint Diseases in New York city was reorganized. From one small room situated in the basement of the original hospital building it has developed into a department occupying almost the entire fourth floor of the new outpatient department building, which was opened in 1939. The number of patients treated with hydrotherapeutic applications during 1942 was 13,231, as compared with about 4,000 treated in 1933. This increase alone would justify the existence of a well equipped hydrotherapy department in a hospital. The cooperation of the medical staff has been most gratifying, and daily orders for hydrotherapy are received and executed for private, ward, clinic and private outpatients.

I feel that it is appropriate here to report on the experience of ten years of operation of this department, representing a grand total of 75,000 cases. It would not be possible in this paper to attempt a detailed description of the apparatus we use. It is complete and compactly and conveniently arranged. I later will call attention to several unusual items of the equipment.

Hydrotherapy has always constituted a practical branch of medicine. Despite much research work very little light has been shed on the exact mode of operation through which hydrotherapy accomplishes its excellent results. All that medical research has given us during the past thirty years is a more or less complicated explanation of a practical result which Priessnitz and Winternitz observed a hundred years ago and which everybody interested in the subject has since confirmed. In this day of highly developed concepts of physiology we are not satisfied with explanations handed down to us from our forefathers and too often copied from one textbook into the new edition of another one. Therefore an attempt will be made to apply some of the scientific observations on practical hydrotherapy to hydrotherapeutic technic, which I sometimes find to be a little too old-fashioned.

The late Simon Baruch may be considered a proponent of modern hydrotherapy. In his book may be found much of the rationale on which present day treatment is based.

In most textbooks on physical therapy too much emphasis has been placed on separating local from general hydrotherapeutic applications. Hydrotherapy does not consist solely of a local application of water for the purpose of relieving a local condition. It should be considered a branch of medicine which is capable of producing tremendous changes in the human system which may lead to a cure but which may cause injury if applied improperly.

The functional significance of the skin organ in the body economy has recently received considerable attention. It is an accepted fact today that the skin is not only the "integumentum commune," i. e., a wrapping paper which holds the bones, muscles and organs together so that we will not

* Read at the Twenty-second Annual Meeting of the American Congress of Physical Therapy, Chicago, September 8, 1943.

fall apart. It plays an important role as a heat regulator to control metabolism, and it has a considerable excretory and absorptive power. Its anatomic structure is well known. Many nerve fibers distributed throughout the skin receive stimuli applied to its surface and transmit these to the centers which in turn influence the voluntary and involuntary processes of the body. Its importance as a protective organ in producing immunity has been emphasized in recent publications. As a test tissue in allergic conditions it is used in our daily practice. Important vitamins are formed in the skin. The skin, therefore, is an important organ. Sulzberger[1] has drawn attention to the fact that "in weight and volume it is the equal of any organ in the body." It is four times as large as the liver.

It is interesting to note that in 1932 Cannon and Sullivan[2] were able to find agglutinins formed in the skin of animals after intradermal injections of paratyphoid B. They concluded that the antibody was produced locally in the skin. Tuft[3] has made reports on the skin as the site of antibody formation.

Many years ago I saw patients with measles and scarlet fever being treated with warm baths of increasing temperature. It was amazing how quickly the rash could be produced when the child showed the first symptoms of an infectious disease. Not only were the baths of value for differential diagnosis; it could be observed that patients treated by this method had a milder course than those treated otherwise. Mothers sometimes are afraid of a bad prognosis when the rash does not appear during the disease. They say, "The disease went inside of the body." In such cases the immunizing function of the skin organ may be poor. Experience has shown that it can readily be stimulated by full baths of increasing temperature. But in these days mothers are unnecessarily afraid of using water on the little patient. "The child may contract pneumonia from such doings." Nothing could be further from the truth. The parents sometimes dread even the application of a wet compress for the relief of a mild cold. The hot packs advocated by Sister Kenny may appear in a different light. Acute poliomyelitis is an infectious disease, and the hot packs may stimulate the immunizing power of the skin and the formation of antibodies.

Our increasing knowledge of the significance of the skin organ is evident in numerous experimental publications which have tried to show how external stimuli of the skin by means of hydrotherapeutic applications are conducted into the inside of the body and what the effects of these stimuli are.

Much emphasis has been laid on the physical effect of heat and cold and mechanical applications on the body, and our knowledge of these effects is extensive. Even here opinions may vary as I tried to show in a publication on hydrotherapy seven years ago.[4]

In hydrotherapy the skin organ acts as a transmitter of the stimuli applied to its surface. Besides this, an exchange of ions takes place in a bath between the water and the skin tissue, which alters the structure of the skin itself. This has been shown by Harpuder[5] and others.

We are able to influence the balance of the sympathetic nervous system, which controls the involuntary processes of the body, by external stimulation of the skin. The tension of the sympathetic nervous system can be controlled, electrolytic changes can be produced and changes in the endocrine system may occur.

In order to guarantee an orderly occurrence of all these changes for the benefit of the patient, the skin organ must be healthy. This fact is frequently overlooked, and many disappointments in applying hydrotherapy are due to the fact that the reactive capacity of the patient has not been ascer-

tained. The skin frequently has lost its power to react favorably to external influences owing to the fact that a large part of it is covered by clothes almost constantly. The skin of the infant looks pinkish and healthy; that of old people loses its elasticity; in chronic diseases the skin assumes a pale and unhealthy appearance. The condition and appearance of the skin, its nutrition and age, are of greatest significance in the reactions caused by external stimulation. This fact is much too little emphasized in daily hydrotherapeutic practice. In the training of the medical student and the physical therapy technician much more emphasis should be placed on recognition of the condition of the skin, its color, appearance and reactive capacity.

Once the student has learned to judge the condition of the patient's skin organ he will easily draw his conclusion as to duration and temperature of the hydrotherapeutic application. He will learn to individualize and will not prescribe the bath merely according to rote. To mention this fact almost seems to be an unnecessary warning for those trained in the field of physical therapy. However, in watching the action of technicians, on the technic of whom the reputation of our specialty rests to a great extent, one cannot but feel that these facts should not be underestimated. In these days much time and money are spent on the teaching of one method of treatment for poliomyelitis, a relatively rare disease, which plays a minor role in causing chronic disability as compared, for instance, with arthritis and other conditions which will benefit from the intelligent application of hydrotherapy. It is hoped that in the near future a similar effort toward training competent personnel will be made not only to cope with other crippling diseases but to benefit all those directly and indirectly connected with the war effort after the war is over. Thousands of men and women in the armed forces will return to civilian life. In individual cases we have already seen that physical and psychic readjustment to civilian life is sometimes a difficult problem. We must be prepared to meet these facts.

Many mild neuroses without apparent cause will respond remarkably well to suitably selected mild hydrotherapeutic procedures. We can almost regard this as an instance of nonspecific treatment for a nonspecific ailment. In cases of neurosis in which the cause, such as bombing, is only too apparent, hydrotherapy also offers excellent prospects of relief and ultimate cure.

In its nonspecific nature hydrotherapy can further be compared to nonspecific protein shock therapy. The latter constitutes a strong stimulation, and strong reactions therefore must be expected. General stimulation by hydrotherapeutic application is much weaker, and therefore the reactions produced by it are somewhat weaker. The summation of the individual stimuli regularly applied will finally produce the cure. Because of the resemblance of the effect of nonspecific protein therapy and hydrotherapy, which act in the same direction, great caution is necessary if the two are employed at the same time. We have observed untoward reactions and aggravation of the condition in patients who, for instance, received sulfur or cabinet baths and injections of a casein preparation during the same period, especially when the two forms of therapy were given on the same day. Both methods may add their effects. But the patient has to be carefully observed with regard to an increase of local or generalized pain or even of body temperature.

Here again all depends on correct dosage. We have time and again drawn attention to the fact that in hydrotherapy not only the temperature but the strength of the stimulation have to be considered. Overstimulation may aggravate the underlying pathologic condition.

During the course of bath treatments the occurrence of a so-called bath reaction is frequently observed. Kornmann,[6] Schulhof[7] and others have made a thorough study of this subject. The bath reaction is the direct result of the effect of the hydrotherapeutic application on the transmitter organ, the skin. It occurs in the body tissues, the metabolism and the circulation. The ion equilibrium of the whole body undergoes a change. This results in improvement of the local circulation, in resorption of pathologic products and in building up of healthy tissue. The entire function of the body is improved; its defense mechanism becomes strengthened.

Clinically the bath reaction manifests itself after the first week in general fatigue, increase of original pain and restlessness. With further treatments, these symptoms subside. Sometimes a second reaction is noted after three weeks of treatment. Increased sensitivity of the nervous system becomes apparent, the blood pressure may rise and the patient sometimes complains of sleeplessness and constipation. An increase of body temperature may be noted and there may also be leukocytosis and increase of the sedimentation rate. The blood calcium is decreased, and the blood potassium is increased. Those supervising hydrotherapeutic applications must be thoroughly familiar with these symptoms.

The success of hydrotherapy depends on the duration of the cure. The duration of the cure in turn depends on the course the bath reaction takes. The shorter the reaction, the better the result.

It is sometimes difficult to guide the patient successfully through his bath reaction. With the increase of pain he is easily tempted to give up and to condemn this method of treatment. Patients in the stage of a bath reaction have frequently gone back to the referring service complaining bitterly. Unfortunately the treatment then is changed by the examining physician, who does not recognize the condition he is confronted with. If a different, strenuous treatment then is instituted, everything may go wrong and the disease be aggravated.

It therefore is apparent that, on the one hand, the patient may not be treated long enough, and, on the other hand, that a disregarded reaction can jeopardize the end result. After successfully overcoming his bath reaction the patient will experience objective and subjective improvement. The increased temperature or sedimentation rate or the abnormal blood picture will come back to normal. Sometimes a final improvement will occur some time after termination of the cure, and some different form of therapy, instituted later on will be credited with the beneficial result. This should be kept in mind when a patient returns from a cure in a bath resort. An increase of symptoms or a disappointment because no appreciable improve- has occurred should be evaluated accordingly by the practitioner. Close cooperation of the family physician and the specialist treating the patient in the spa therefore is in order.

In view of the possibility of a bath reaction, the importance of not overtreating the patient must be emphasized. Treatments may have to be interrupted until the increased symptoms have disappeared. We have frequently obtained a better result with patients who were hospitalized as compared with those who were treated ambulatorily. The reasons for this observation should be self evident.

In a previous publication[4] I described the technic and physiology of partial baths of increasing temperature. Their value now is firmly established. The true peripheral vasodilatation they produce has proved to be of great help in the treatment of peripheral vascular diseases. The arm bath has a soothing effect on the severe pain in the extremities and even a

patient with advanced extensive gangrene will benefit. Even during attacks of great pain the patient will fall asleep shortly after termination of the application, or he will rest comfortably. Besides, this is a way to make a patient perspire with the least amount of strain on the circulation. Patients with rheumatoid arthritis have benefited from this method.

The steam jet is a form of therapy now found indispensable. It also has been described previously.[4] In our new department six steam outlets, built into the walls when the new building was erected, are in constant use. Provisions not visible from the outside have been made to carry accumulating condensed water away in order to prevent burns on the patient's skin. Application of the steam jet causes an immediate dilation of the capillaries of the skin followed by a deep-reaching hyperemia. The mild mechanical effect of the flowing steam has to be considered too. Its great pain-relieving effect is used with good results in cases of sciatic neuritis or the sciatic syndrome or in cases of acute bursitis around the shoulder joint. Its healing effect on sluggish wounds or ulcers should be emphasized. The steam jet has become an almost regular adjuvant in the treatment of inflamed hemorrhoids and of rectal edema. Anal spasm can also be relieved by this method.

Our therapeutic pool has been in operation for the past four years. The technicians work in shifts af about two hours per session. Since the advent of the new treatment for poliomyelitis, the pool treatment has been reserved for patients with chronic orthopedic conditions. Those with tendon and muscle transplants are treated regularly after operation. Patients who have had arthroplastics are taught their first carefully guided movements in the pool.

Patients with chronic arthritis and especially those suffering from low back pain are also being treated in the pool, and the Hubbard Currence tank has proved to be of great value because of its combined whirlpool effect. This has been described frequently, and it is mentioned here to show our satisfaction with it. We usually treat the patient first with the steam jet for fifteen or twenty minutes, after which he is transferred to the tank. Massage follows if necessary.

For the past year and a half we have had an opportunity to become more familiar with the hydrogalvanic bath. This is by no means a new form of therapy in physical medicine. Its merits and dangers have been described in all the textbooks of recent years. The dangers have been eliminated in the improved apparatus now available. As to the merits, these have been greatly underestimated, as has been the value of the galvanic current in general. The short wave enthusiasm seems to have died down to a considerable degree, and according to recent publications we have returned to the low voltage currents, which so beautifully fit into our modern conception of physiology.

The physiologic effects of the galvanic current are well known. To describe them in detail is not within the scope of this paper. A few words, however, should be said as to why the application of the galvanic current in a full bath makes it a useful form of therapy in physical medicine. The use of water in a bath tub will produce a perfect contact over a large skin area for the transmission of the electric current. Stimulation of the skin takes place, with all the consequences described at the beginning of this paper. The modern generator for galvanic currents which I have used in two institutions and in my private work permits the application of the current in fine gradations and variations of strength.

I am fully aware of the migration of ions, electro-osmosis and all the well known physiologic changes which occur when the galvanic current is

applied to the body. But I feel that regarding the hydroelectric bath the results obtained are largely due to stimulation applied to the skin surface. The question asked should therefore not be: How much current passes through the body and through the water, respectively? The figures given for the percentage of current going through the body vary from 10 to nearly 40 per cent. The skin resistance varies greatly, and the applied voltage constitutes an additional factor. The position of the electrodes has to be considered, too. The question rather should be: To what degree can we stimulate the skin organ in order to tone the system?

We know very little about the effect of the galvanic current on the human body. We know that electro-osmosis and ion transfer take place, we notice dilatation of the skin capillaries, but we do not know what electrochemical actions take place within the bdy. We cannot yet evaluate what it means when the blood or the body fluids are charged with electricity, regardless of how small this charge may be. Some day we may know this and then we will know whether a high voltage or a low one should be used in the individual case and whether the current should be applied for ten minutes or for thirty minutes for the treatment of a certain condition. I admit that this discussion is somewhat academic, but before we learn these details the hydrogalvanic bath is and remains a form of nonspecific therapy. The combination of water—the temperature of which can be changed at will—with the current—the strength and distribution of which are controllable—makes it a desirable form of therapy. Hydrogalvanism makes a relatively even distribution of the current possible and permits a continuous simple observation of the parts of the body under treatment.

At the Hospital for Joint Diseases and at other institutions I have given many hundreds of individual treatments with the full bath as well as with the four cell equipment. No untoward effects have been observed.

The duration of the individual treatment varies from fifteen to forty-five minutes. Any bath reaction must be dealt with carefully by reducing the temperature of the water, the strength of the current and the duration of the application. It has been observed that an increase of symptoms may occur after two to four treatments. It must be explained to the patient that this does not mean an aggravation of his condition but a bath reaction which has to be controlled. After the bath the patient must rest at least one-half and preferably one hour. Massage must be given where indicated. The conditions treated all belonged to the rheumatic group. The best results have been obtained when pain was the dominant symptom.

We have had an opportunity to treat a series of patients with a pain syndrome recently described by Telson.[8] These patients complained of paroxysmal attacks of severe pain either in one upper or in one lower extremity. The pain appeared in the late afternoon or at night and was aggravated by standing or walking. There were complete lack of muscle spasm and list of either the back or the neck. The knee jerk and ankle jerk were usually absent. No localized tenderness could be found. Immediate and severe atrophy of the part involved was noticed and sharply demarcated paresthetic areas were present. Roentgen ray and laboratory check-up gave negative results. The patients had not responded to any ordinary conservative methods of therapy. Pathologically they probably had true neuralgia or neuritis.

We treated these patients with the hydrogalvanic bath. All of them responded immediately during and after the first treatment. After one to three baths they were able to sleep again, and they were discharged cured after from five to twelve treatments.

We observed the same favorable results in cases of true sciatic neuritis. Patients with osteoarthritis also responded favorably, especially when their symptoms were due to secondary muscle spasm or fibrositis. In the treatment of rheumatoid arthritis our results have not been conclusive. Patients with this condition so far have reacted as they would have with any other form of therapy, some improving temporarily and some not at all. One patient with Parkinson's disease reported more relaxation after a series of baths than he had experienced with any other form of therapy.

Hydrogalvanic partial baths given with the four cell outfit have proved to be of great value. Some patients with bursitis of the shoulder girdle have responded well to these baths in combination with histamine ion transfer.

In view of the excellent results which have been obtained in so many and in such variety of pathologic conditions, it is unfortunate that hydrotherapy is not used more extensively. With the present curtailment of the manufacture of physical therapy apparatus, we could well look to the ordinary bath equipment found in every hospital and home as a means of applying many hydrotherapeutic procedures.

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Discussion

Dr. Robert L. Bennett (Warm Springs, Ga.): I am happy to have the opportunity to open the discussion of Dr. Behrend's paper. Adequate discussion of a subject of this broad scope would require far more time than I am permitted this afternoon and far more knowledge of the subject than I possess. However, there are certain points brought up in this paper which deserve further emphasis and discussion.

It is not a new experience for those of us practicing physical medicine to be blocked by our lack of knowledge of the physiologic responses of the body to the application of various physical agents. We realize that no endeavor in medicine has the right to consider itself a specialty until its members work together to evaluate its results in terms of basic scientific data. The recent developments in hydrotherapy brought out in this paper are certainly steps in the right direction, but they must be followed up, correlated and taught by men like Dr. Behrend, who have the interest of physical medicine at heart and who have the advantage of well equipped departments and a large number of patients to study. If sound clinical results are brought to the attention of interested medical men, basic research follows as a natural sequence. The great interest that followed the introduction of physically produced fevers for the cure of disease initiated countless studies on the physiologic reactions of the body to abnormal temperatures. Studies on the reaction and adaption of the circulatory and respiratory systems to the application of heat initiated by fever therapy contributed greatly to the appreciation of many phases of physical medicine. Likewise, the renewed interest in the treatment of poliomyelitis has stimulated the study of muscle and nerve physiology and bodily mechanics, which will have far reaching effects on many forms of physical therapy.

Dr. Behrend mentioned that much money and time are spent for the teaching of one method of treatment of the relatively rare disease of poliomyelitis. While the training of competent personnel in the treatment of any serious crippling disease, however rare, needs no defense, it is only fair to admit that if we can show that, for example, hydrotherapy is as essential in treating arthritis as certain early physical therapy measures are in treating acute poliomyelitis, we will

have no trouble raising the money to train technicians in the use of hydrotherapy in arthritis; and we can be sure that the whole field of physical therapy will profit from this additional training of its technicians, on whom rests, to a great extent—as Dr. Behrend so aptly remarked—the reputation of our specialty.

Dr. Behrend stated that since the advent of the new treatment of poliomyelitis his therapeutic pool has been reserved for patients with chronic orthopedic conditions. Our experience at Warm Springs in this regard may be of interest. When, in the fall of 1941, we began to use the Kenny method in the treatment of acute and convalescent poliomyelitis, we realized that Miss Kenny had no use for water as a medium to carry out muscle reeducation. She told me flatly several times that Warm Springs Foundation should fill its pools and grow flower gardens on top of them. At any rate, during the first year's trial of the so-called Kenny method, we used underwater therapy in no case of acute and convalescent poliomyelitis but confined our pool treatment to chronic cases, particularly the preoperative and postoperative patients. Then almost imperceptibly we began to try underwater therapy for convalescent patients. For example, a patient came in to us two months after the onset of acute poliomyelitis. He was stiff and sore and apprehensive and mentally depressed. We began our usual routine of hot packs, gentle passive motion, etc., but progress was discouragingly slow. The patient and his technician suggested that we try the pool for a short time once or twice a week. The result was dramatic. The patient relaxed in the pool as he had never relaxed on the treatment table. His joint range increased rapidly, his muscle pain diminished and his whole mental attitude changed for the better. This was not an isolated case, because we soon found that many of our patients reacted in the same way. We began to realize that there was a definite place for underwater therapy in the treatment of convalescent poliomyelitis, and we have incorporated this phase of hydrotherapy in our routine.

Dr. Richard Kovács (New York): I wish to discuss the hydrogalvanic bath phase of Dr. Behrend's presentation. I have been familiar with the extensive use of hydrogalvanic baths in physical therapy departments abroad, and it seems regrettable to me that in this country much use for this treatment has until now not been found.

Two years ago, when an improved hydrogalvanic apparatus became available, I was glad of the opportunity to put it to use at the Physical Therapy Department of Polyclinic Hospital in New York. Without making any special efforts to solicit patients to be sent for this treatment, I was surprised to find that within a few months an increasing number of arthritic patients — nurses and doctors' families — came, referred for treatment especially in polyarticular affections.

I want to corroborate Dr. Behrend's experience that the relief of pain in some of these cases which were heretofore resistant to all other forms of treatment was quite impressive. In addition, there was a marked influence on the general strength and comfort of patients.

Subsequently, a local galvanic bath was installed, at the hospital and at my office, and again I was pleased to find that in many cases of polyneuritic affections, in peripheral nerve injuries and in traumatic and trophic affections of extremities, the results were quite satisfactory. Some of these patients had not done very well under continued use of short wave therapy and other heat measures. Others expressed distinct relief when the ordinarily useful but in summer-time most oppressive heating measures were replaced by the much more comfortable and quite as effective hydrogalvanic application.

I agree with Dr. Behrend that in all physical therapy departments, a hydrogalvanic installation should prove to be a desirable and useful adjunct.

THE HUMAN FOOT *

A Study of Its Structure and Function — New Functional Exercises

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Every physician engaged in orthopedics faces the problem of adequate foot therapy. The treatment of flatfoot has been unsatisfactory in the majority of cases, a fact proved by the variety of plates, shoes, exercises and surgical procedures employed and by the therapeutic nihilism which sometimes replaces a method which has failed. As a result of such confusion, every clinic and physician differs with regard to type of foot therapy.

The need for proper treatment based on exact diagnosis and better understanding is made evident by the ever increasing number of young and old with the signs of weak feet. The importance of hygiene and correction in childhood is self evident, since most adult foot patients are persons who did not have the benefit of early correction, while people who had proper foot care as children enjoy freedom from orthopedic measures.

The first definition of orthopedics, given by Dr. Andry in 1741, as "the art of preventing or correcting deformities in childhood," applies especially to the feet. Since the structure and function of the growing foot can be easily influenced by providing the optimal skeletal and muscular correlation, the emphasis rests on treatment by early exercises.[1-2] The human foot, providing stability and locomotion, is the product of bone-muscle forces resisting the influence of gravity. It is also the victim of a degenerating shoe style and misuse, which mark it the most neglected organ of the human body, although next to the brain it is the distinguishing feature of the human race. The resulting mechanical and muscular disorders can be corrected by proper exercises, the wearing of plates being restricted to a minimum. The exercise treatment applies to all "weak feet" due to a pronation-valgus position of the heel and subastragalar portion, which is the result of the medially shifted leg-foot axis in the course of evolution (fig. 1).[3]

Since so little has been done about weak feet, the history in a typical case is about as follows (slightly dramatized):

For the first three years, correction by the wearing of heel wedges and leather cookies was ordered by the physician. Because of pain, metal plates of various types were later ordered by orthopedic physicians. These were discarded in high school because the patient found them too clumsy; also, they ruined her stylish shoes, and one cracked. The patient started a few exercises, which she gave up because they were too boring. She read about a new type of shoe with orthopedic plates, and although these were expensive she purchased them and wore them for two years. She then started monthly appointments with a chiropodist because of calluses under the metatarsals and on the toes; also, she had strapping every week for two months. She then lost patience and for a while did nothing. Presently a friend advised her to wear Thomas and Denver heels. Later the patient was treated for a short time by a physician for gout of the big toe, which turned out to be bunion and hallux rigidus due to pronated feet. She decided to go to a watering place for massage and exercises, where she was told by a physician that cure at the age of 35 was not possible but that she should start systematic exercise treatment with her children.

Structural Analyses of the Foot

Evolution. — The foot of modern man is the yet unfinished result of osteoarticular and musculoligamentous adaptation for stance and locomotion

* From the Blythedale Home Hospital for Crippled Children, Valhalla, N. Y.
* From the Hospital for Joint Diseases, New York City, N. Y.

against the force of gravity.[4-5] The evolutionary stages from the amphibium-reptile-mammalian to the anthropoid and man's foot are characterized by the transformation of a flexible grasping organ, with twisted metatarsals and an opposing hallux, to a firmly interlocked leverage system, with five supporting untwisted metatarsals and shortened toes. While the diverging, opposing and strongly developed grasping hallux, a necessary feature in arboreal life, became parallel attached to four lateral digits in the same plantigrade plane, the foot axis shifted medially between the first and second metatarsals, bearing the forward thrust and securing greater vertical balance. The heel dropped from the fibulare of the reptiles, was enlarged through

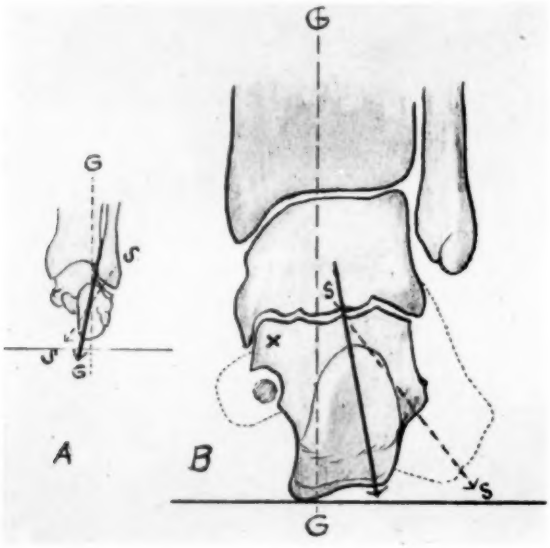

Fig. 1. — *A*, position of calcaneus in Neanderthal man. *GG* indicates the line of gravity. The black arrow shows the axis of the calcaneus in varus position which is more pronounced in the chimpanzee, as indicated by the dotted line *SS*. *B*, position of the calcaneus in modern man. The line of gravity is shifted medially. The black arrow shows the axis of the calcaneus in valgus position, which increases to 15 degrees in flatfoot, as indicated by dotted line *SS* and the dotted outlining of the bone. The counter-ridge of the sustentaculum tali (*x*) is supported by the flexor hallucis longus, which forms a suspension strap below it.

weight bearing and changed the supinatory position typical of the anthropoids into a pronated one, with the sustentaculum tali forming a counter-ridge (fig. 1). With the tarsal bones tightly interlocked, the metatarsals beneath the talus elongated and the four lateral digits reduced, the foot of man retains some grasping power while functioning as a leverage system. The evolutionary process is easily understood if one holds the arm in mid-position with the thumb opposing the palm; by turning it in pronation with the thumb adducted, one reproduces the plantigrade plane.[2-6]

Skeleton of the Foot. — Anatomically, the foot has two longitudinal rows (fig. 2). The medial represents the inner longitudinal arch, which is formed by the astragalus, the scaphoid and the three cuneiform bones, with the first, second and third metatarsals and the corresponding toes. The lateral row represents the outer longitudinal arch, which consists of the calcaneus and the cuboid lifted on the tuberosity of the fifth metatarsal, with the fourth and fifth metatarsals and the corresponding toes.[7-8] The astragaloscaphoid unit supported by the ligamentum calcaneonaviculare plantare rests as superstructure

on the medially slanting plane of the calcaneus and represents, as subastragalar joint, the weakest point in the inner arch structure. Its weakness becomes more pronounced with the change in position of the calcaneus from supinated to pronated, as previously mentioned, while the sustentaculum tali is the only bony structure acting as a counter-ridge against a downward tilt of the inner arch. The heel forms the proximal portion and the toes the distal end of the longitudinal arches, with the five metatarsal heads in variable contact with the ground. With decreasing divergence of the hallux and the untwisted metatarsals in parallel position, the body weight is distributed on the foot as a whole. The five metatarsals, with the second as the highest and the fifth as the lowest, form buttressing pillars of support for the body weight. "Structural Stability" is guaranteed by contact with the ground of the heel, the base of the fifth metatarsal, the heads of the five metatarsals and

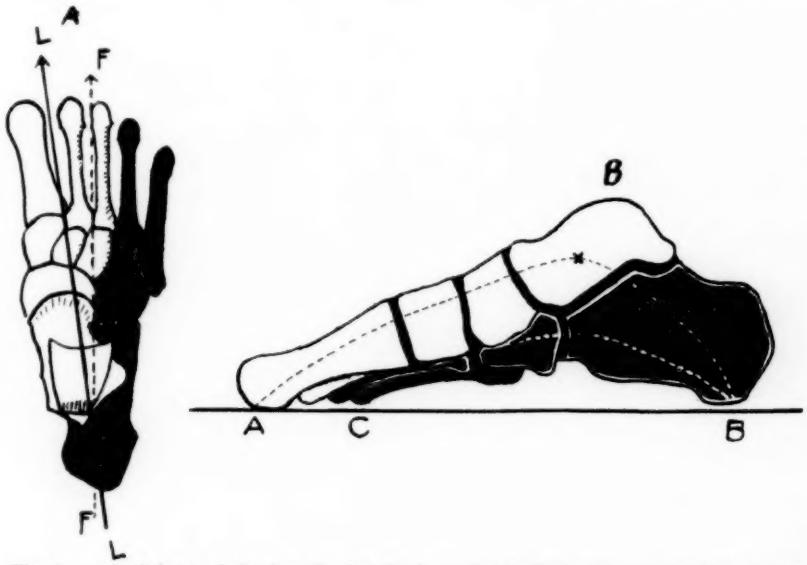

Fig. 2. — *A*, skeleton of the foot showing the inner longitudinal arch segment (white) and the outer longitudinal arch segment (black). *LL* indicates the "leverage axis" running between the first and second metatarsals, and *FF*, the "functional axis" between the second and third metatarsals. *B*, side view of both longitudinal arches. The height of the inner arch (*AB*) is 5 to 7 cm.; *x*, indicates the center of gravity in the talus and calcaneus. The height of the outer arch (*CB*) is 2 to 3 cm. The white shows the inner grasping segment and the black the outer weight-bearing segment.

the five toes. The two last mentioned are not in constant contact with the ground, except for the heads of the first and second metatarsals, which bear the body weight constantly (fig. 3). The two longitudinal arch systems of the first and fifth metatarsals show broad proximal, plantar bases, which are missing in the second, third and fourth metatarsals. These are characterized by longitudinal muscle grooves.[9] The transverse structures are formed by the scaphoid, the first cuneiform, the cuboid and the base of the fifth metatarsal, representing a constant, rigid "Posterior Transverse Arch," while the heads of the five metatarsals form the elastic "Anterior Transverse Metatarsal Arch." The latter, with the head of the second metatarsal as the highest point, is not a real vault construction but a variable bone row, either completely or only partly in contact with the ground. But one cannot deny the existence of such a functional structure, as Dudley Morton does. By various muscle functions, especially of the toe flexors, the bony structures become shortened and raised. The terminal phalanges show, according to age, varying degrees of disuse, atrophy and flexion contractures, most pro-

nounced in the fifth, fourth and third toes. The sesamoids underneath the basal big toe joints serve as a rocking surface. The bony structures show the influence of muscular activity, such as medial excavation of the heel, harboring the whole flexor — and part of the supinator group; a groove below the sustentaculum tali, resulting from action of the flexor hallucis; a peroneal groove beneath the cuboid, and muscle impressions from the lumbricales and interossei function along the lateral portions of the second to fourth metatarsals.[10-11] The stability of the foot is greatly increased by the external ligaments and fascial structures. While there is a bony stabilization by the interlocking of bony planes on dorsiflexion, there is mainly a ligamentous stabilization on plantar flexion. The ligamentum calcaneonaviculare plantare forms a necessary support for the talus,which otherwise would sag down with the head portion. That joint contact is enforced by the dorsal ligamentum bifurcatum, which guarantees the firm contact of calcaneus, scaphoid and cuboid, while the ligamentum plantare longum, between calcaneus and metatarsals, increases the stability and elasticity of the arch. This is increased by the plantar fascia—aponeurosis plantaris—which, connected with the dorsal fascia, keeps the plantar muscles together and helps carry the body weight.[3-7] The fact that in children the bony arch shows increasing weakness on weight bearing is due to incomplete development of the plantar fascia and to elasticity of the soft tissue pad between plantar fascia and skin, which causes a sagging of the calcaneus up to 8 mm. As Lapidus[12] recently pointed out, the plantar fascia acts as a tie rod, taking up all the tensile stresses. The integrity of the longitudinal arch is maintained by the ligamentous rather than by the muscular structure. The presence of these ligamentous and capsular reinforcements explains the preservation of a well arched foot without weight bearing and the collapse of the arches due to generalized or local ligamentous weakness on weight bearing.

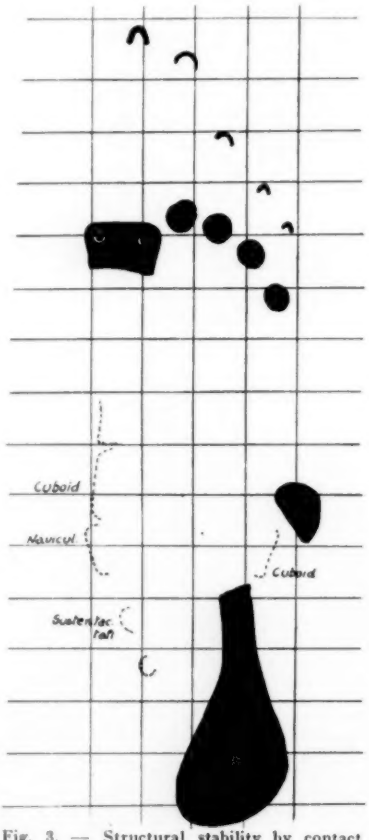

Fig. 3. — Structural stability by contact with the ground of the heel, the base of the fifth metatarsal, the heads of the five metatarsals, the two sesamoids under the first metatarsal and the toes. The dotted line shows the bones of the superstructure.

Development of the Foot. — The anatomy of the foot undergoes marked changes between infancy and childhood.[13] The foot of the newborn infant has the heel almost horizontal to the ground, with the talus pointing obliquely down and forward, the cuboid being the only midtarsal bone (figs. 4 and 5). Instead of the bony longitudinal arch, which is absent, the muscle masses form a "Soft Tissue Flatfoot."[14-15-16] The horizontal position of the heel is similar to that found in clubfoot. Racial differences are noticeable, with a smaller heel in the white (fig. 4*A*) and a posteriorly elongated heel in the Negro race (fig. 4*B*). With the foot in a neutral position, the metatarsals are in adduction. This is most pronounced in the first metatarsal, while the fifth metatarsal is straight. The basal phalanges and the meta-

tarsals form a well defined transverse arch; the center is formed by the second to fourth metatarsals and phalanges, while the first and the fifth segment are in contact with the ground. The anatomy of the foot of the new born infant is characterized by a horizontal heel, adducted metatarsals, except the fifth, a well developed transverse arch and absence of a longi-

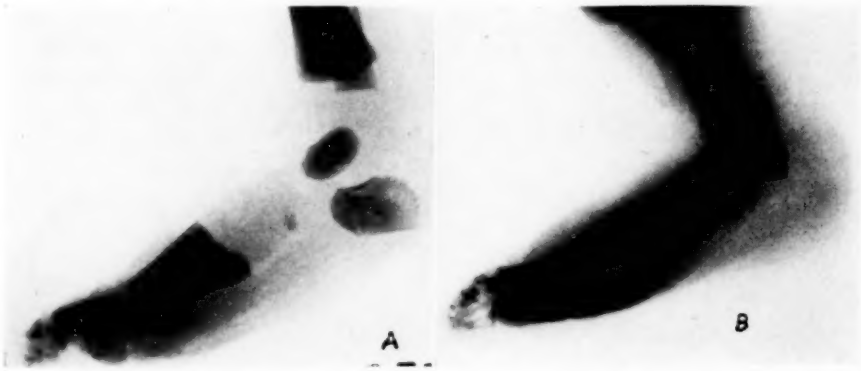

Fig. 4. — *A*, foot of a newborn infant, with the heel horizontal, the talus oblique and the cuboid present. There is soft tissue flatfoot, but the metatarsal arch is well formed. *B*, foot of a newborn Negro infant with a more elongated heel and a slanting talus. The longitudinal arch is absent but the transverse arch well developed.

Fig. 5. — *A*, fore part of the foot shown in fig. 4 *A*, with the first three metatarsals adducted and the fourth and fifth straight and shorter. *B*, the same conditions in the foot of a newborn Negro infant.

tudinal arch, which is replaced by muscle and soft tissue "pseudoflatfoot" pads.

At the end of the first year, in a Negro baby with markedly everted feet the talus-calcaneus position is unchanged, with the heels horizontal, the tali oblique, the transverse arches well developed and formation of longitudinal arches owing to an increase in the plantar muscle flexor substance, which is replacing the diminishing sole fat (fig. 6). During the next two years, with the appearance of the tarsal bones, the calcaneus, with the

horizontal placed talus-scaphoid segment, forms a "Longitudinal Arch Angle" with the bones of the middle and fore part of the foot. With an increase of muscle substance, represented by the plantar foot flexors and distinctly separated by a strong fascial structure from the diminishing soft tissue sole pad, the appearance of a trabecular system reflects the functional adaptation of the growing bone (fig. 7). The trabeculae follow an arc of compression stress from an inner reinforcing bridge arising from the tuber calcanei and passing through a horizontal calcaneal plane, upward in the talus body and then across the joints along the dorsal metatarsal head region, contributing to the "structural stability" and resiliency for shock absorption. According to Morton,[4] the tension trabeculae inside the bones,

Fig. 6. — Foot of a year old infant with beginning formation of the longitudinal arches, well developed toe flexors and the sole fat replaced by muscle.

with plantar ligaments outside, indicate that the ligaments are modified portions of the bones themselves, although not permeated with minerals.

Mechanical Functioning.[7-17] — The human foot can be considered a leverage system in tripod form, with the heel as the posterior and the arched first and fifth tarsal-metatarsal toe segments as the anterior arms. The propelling force exerted through the heel by the calf muscles is thrown forward through the five metatarsal heads, supplanted in their leverage action by the grasping function of the toes. The toe segment serves as rolling off plane in the leverage system, as well as longitudinal and transverse arch preserver when actively flexed. It also acts during walking and increases the margin of body stability. The "leverage axis" runs between the first and second metatarsal segments (fig. 2*A*). The center of gravity, perpendicularly located in front of the angle joints, extends through the tibia and the midpoint of the upper portion of the talus. Each shift of the weight center from the center of gravity causes muscular action to safeguard body balance. The stability of the foot is also dependent on a "functional axis," which runs between the second and third metatarsals, dividing the foot into a lateral, tightly interlocked, stabilizing, weight-bearing segment and a medial, grasping, kinetic segment[4] (fig. 2*A*). The pressure is transmitted to the ground by two bony channels arising from the calcaneus, one medially through the talus-scaphoid-cuneiforms and the first and second metatarsal and one lat-

erally through the cuboid and the three outer metatarsal bones. While the foot is an independent mechanical unit when off the ground, it becomes part of the leg when in contact with the ground. The motions taking place in the subastragalar joint, inversion-supination, adduction, plantar flexion, eversion-pronation, abduction and dorsiflexion, are caused by bony interlocking motions above the malleolar fork and the "kinetic muscle chain." When a person is standing on tiptoes, the gravity line coincides with the functional and leverage axis, requiring perfect muscular control of the subtalar joint. The calcaneus, acting as posterior lever by its position and shape, influences the anterior lever segment. A longer calcaneus, typical of the Negro race,

Fig. 7. — Foot of a 4-year-old child showing further development of the longitudinal and transverse arches. An increasing mass of muscle is separated by a strong fascial layer from the diminishing sole fat. A trabecular system has appeared along the arch of compression stress.

provides greater leverage excursion, and the amount of calcaneal valgus or varus position determines the shifting of the weight-bearing axis medially or laterally. The shape of the heel shows a marked lateral orientation of the tuber, with a large medial groove covered by the sustentaculum tali. These structures compensate for the calcaneal valgus tendency by supinator action of the flexor hallucis longus muscle, which functions as an indispensable suspension strap below the sustentaculum tali (*X* in fig. 1*A*). Since the gravity line runs medially from the center of the ankle joint, each step taken in the usual fashion of straightforward or slightly abducted feet forces the heel into pronation position, which is actively counterbalanced by the flexor hallucis function, supporting the sustentaculum tali, and the adductor and supinator effect of the triceps surae. If, however, the weight stress is carried from the beginning in a direction from the supinated heel toward the base of the fifth metatarsal, the postural and structural stability of the whole foot is guaranteed. The talus acts as the keystone of the foot arch, carrying the whole body weight. On plantar flexion, ligamentous and muscular stabilization provides the rolling off of the foot, while the talus and malleolar fork, in firm static contact, stabilize the foot on dorsiflexion with the midtarsal bones interlocked. While the posterior arm of the foot lever influences pronation and supination, the anterior arm of

the lever, with the five metatarsals and their heads, forms a system designed to resist the horizontal push and to carry perpendicular weight. Each step, shifting the body weight toward the metatarsal heads, increases the stability of the longitudinal arch, pressing the bones of the midtarsal region tightly together. The digits serve (1) to increase the stability of the foot by providing an enlarged supporting surface, (2) to carry out a grasping function with the transverse longitudinal arches and (3) to provide a rolling off plane and buffer with the plantar cushion. Loss of the digits is equal to a 40 per cent reduction of foot function. The weight-bearing plane runs from the tuber calcanei toward the base of the fifth metatarsal bone, along the fifth metatarsal and across the five metatarsal heads, ending at the head of the first and second metatarsals. Because of this course, the function of the lateral toes (the fourth and fifth) is one of leverage, while the medial toes (the first three) act as grasping organs, providing for a firm grip on the ground (figs. 2*A* and 3). When there are arthritic changes in the metatarsophalangeal joints, especially of the big toe, the distal end of the foot lever becomes painful and the rolling off plane of these joints is lost. The preservation of the motions of the toe joints is therefore of great importance for the smooth functioning of the foot leverage system.

Muscles of the Foot

Postural Stability. — Besides the structural stability provided by bony and ligamentous contact and observed mainly in standing, there is a "postural stability" maintained by proper functioning of the muscular apparatus in walking and grasping. Without proper functioning of the muscular arch preserver units, the postural stability of the foot is endangered. Besides the force of gravity, the muscular action is the only factor in the arch formation. While the extrinsic muscles maintain the longitudinal arches, the intrinsic muscles help the adjustment of the transverse arches.[18-19] Only the essential muscular arch preservers will be analyzed. By their postural tone they prevent sagging of the vault structures. The normal foot becomes shorter and narrower under weight bearing, because the long flexor muscles act as stirrups, or drawbridge arms, while the short muscles, by bowstring action, stiffen the arch against the gravity thrust. The muscles compensate for the mechanically weak segments in the foot; they guarantee adaptation to uneven ground in the necessary planes and maintain the optimal function of the foot through life. Insufficiency of the muscles endangers structural and postural stability, with interfering deformities as a result of lack of muscular training and exercise. The foot maintains perfect shape and function without weight bearing; the moment it strikes the ground, simultaneous muscular action is necessary to preserve its postural stability. There is no isolated muscular function. Each motion is carried out by coordinated muscle groups, with one or two muscles as the main motor. This applies mainly to the complex subastragalar joint motions in the horizontal planes — adduction-supination-dorsiflexion and abduction-pronation-plantarflexion—while usually one muscle is sufficient to carry out dorsiflexion and plantar flexion in the vertical plane. The resisting force from below, represented by the ground, counteracts the gravity force from above and brings the postural muscles to maximal action. When it strikes the ground, every position of the foot influences, through a "kinetic muscle chain," the position of the leg and the pelvis.[17] This is particularly evident on supination of the foot when it comes in contact with the ground, followed by outward rotation of the lower part of the leg (correction of static bow legs) and of the knee, retroversion of the greater trochanter, erection of the femoral neck

and backward tilt of the pelvis, noticeable on palpation of the sacroiliac joint, with tightening over that area evident by increased tone of the gluteal muscles and tensor fasciae. The intrinsic, or short, foot muscles carry out the narrowing and shortening of the foot in transverse and longitudinal planes. The extrinsic, or long, foot muscles provide complex motions in three planes and are the more efficient the greater the angle of the leg-foot axis and the distance between the origin and insertion of the muscle.[8-9] They are able to change their functions from inverters to everters and vice versa, according to the position of the foot. One striking example of such "substitution" is the peroneus longus muscle, which, in spite of being a typical foot abductor, may change its function and help to adduct and pronate the fore part of the foot. The dorsiflexors and plantar flexors of the foot, also, can act either as adductors or abductors, according to the varus or valgus position of the heel and tarsal region. While loss of plantar flexion and dorsiflexion can-

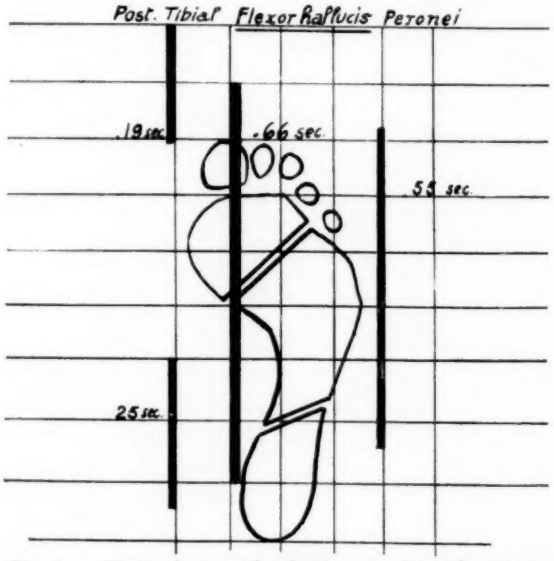

Fig. 8. — Phase of contraction in the muscular arch preserver units, with predominance of the flexor hallucis longus muscle, active during rolling off of the heel, middle and fore part of the foot (modified from Schwartz and Heath).

not be substituted for, pronation and supination can be maintained to some degree even if one or two muscles are missing. Two of our patients with complete loss of both tibial muscles were able to stand with a well arched foot by means of a well functioning flexor hallucis. As soon as weight is borne, the anterior and posterior tibial muscles, with the flexor hallucis, the so-called longitudinal arch preserver unit (Hoke), go into action.[10] The posterior tibial muscle while in adduction presses the scaphoid against the head of the astragalus. This allows the anterior tibial muscle to lift up the bone lever of the scaphoid and internal cuneiform bones. If the joint contact between the scaphoid and cuneiform bones becomes loose on abduction of the foot, the anterior tibial muscle loses its arch-lifting power. The flexor hallucis, which runs nearest to the axis of the leg and foot under the sustentaculum tali, using it for a fulcrum, prevents by its stringlike action the pronation and downward tilt of the astragalus.[3-20-21] At the same time, the anterior and posterior tibial muscles form another unit with the peroneus longus muscle which fixes the metatarsus in the transverse direction and raises the arch by a stirrup-like action over the anterior and pos-

terior tibial muscles and the peroneus sling, compressing the foot in the direction of a "transverse arch preserver unit." Of all the long foot muscles, the flexor hallucis longus is the most powerful one because of its unique course, originating far laterally along the posterior surface of the fibula and ending far medially at the end phalanx of the big toe. It supports not only the sustentaculum tali, but all the metatarsal bones, having an even greater momentum than the flexor digitorum longus, which has only half its mass. It serves as a plantar flexor, adductor and supinator and maintains the longitudinal arch by preventing valgus position (fig. 8). It is the main support of all plantar flexors and supinators and serves also as rolling-off muscle in walking. The extensors are essentially "releasing" or "recovery" muscles. The gastrocnemius and soleus, or the triceps surae, are ideally designed for leverage. Both the peroneus brevis and the peroneus longus, especially the former, act with abduction, plantar flexion and pronation as exquisitely painful flatfoot muscles because they cause a position in which the talus is gliding off the calcaneus. Both peronei originated from a primi-

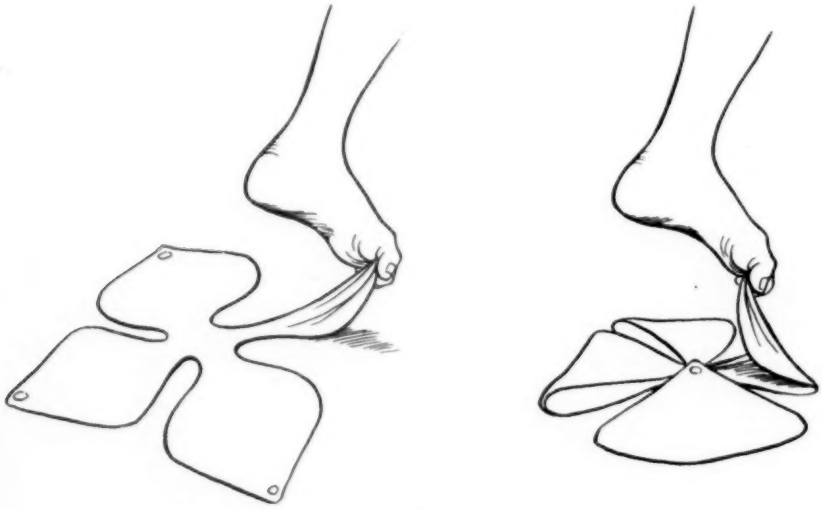

Fig. 9. — Envelope exercise.

tive fibular extensor which was transformed from a foot extensor into a plantar flexor. This change happened in the reptilian modification, when by downward and backward carriage of the fibulare, the transposed fibular extensor migrated across the sole of the foot (peroneus longus), opposing the stress of locomotion exerted in the transverse arch.[4-5] This peroneal transposition offers a mechanical advantage in the human foot, bringing the sole in firm contact with the ground and allowing a free rolling-off of the forepart of the foot over the first and second metatarsal segment.

The mechanical disadvantage of the supinator muscles against the peronei calls for more training and support of the first group.

The intrinsic muscles, represented by the short toe flexors, the lumbricales, the interossei and the adductors and abductors of the first and fifth toes, serve as stabilizers for the longitudinal and transverse arches and prevent their spreading. From the intrinsic muscles, which have undergone marked reduction in man, the lumbricales and the interossei, with the plantar aponeurosis, reinforce the arch structure and metatarsal position.[18] They also increase the flexion power of the long flexors. The short foot muscles represent one-fourth of the foot muscle mass. The ability of the interossei

alone to abduct the toes from the axis running through the second metatarsal bone is usually lost in adults, but these muscles serve as abutment countersupport for the metatarsal arch, while fixing the joints against the metatarsal heads. The presence of three strong muscles around the big toe (abductor, flexor, adductor hallucis), indicates the importance of the first metatarsal segment. The adductor hallucis, with its transverse head, causes narrowing of the foot, while the oblique head shortens it. The abductor hallucis, with one-half more muscle volume than the adductor, is the shortest flexor, reinforcing the medial portion of the metatarsal arch, shortening the foot, flexing the big toe and abducting it from the second toe. It transforms the abduction in adduction, favoring a hallux valgus po-

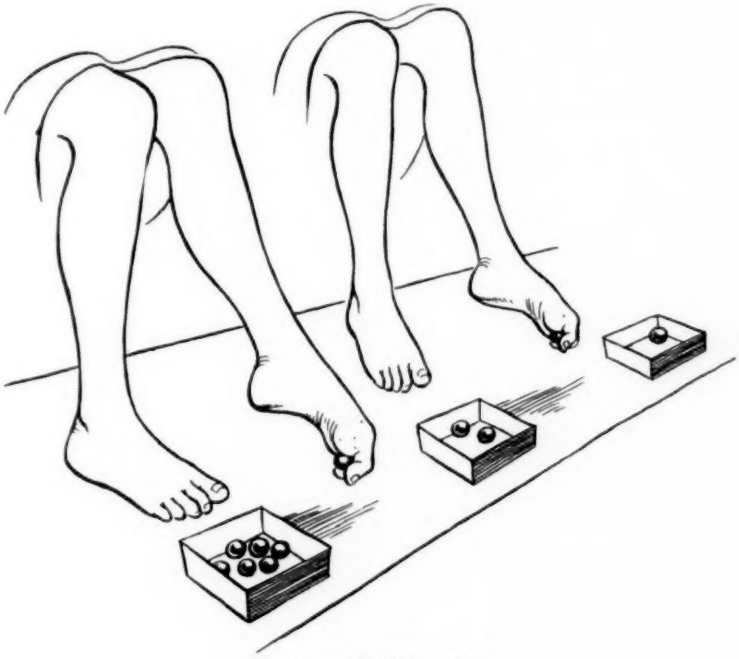

Fig. 10. — Marble exercise.

sition if the big toe is turned laterally. The flexor hallucis brevis, covered by the abductor, also reinforces the longitudinal arch. With its two heads attached to the two sesamoid bones, it forms the groove for the flexor hallucis longus and serves as a powerful plantar flexor when one is standing on tiptoes. The two muscles together even make standing on the terminal phalanx, as in ballet dancing, possible. The strong plantar aponeurosis, communicating with the dorsal fascia, increases the function of the arch forming the sole muscles, keeping their bellies tightly together.

Painless functioning of the human foot depends on adequate muscle tone, which can be preserved or regained and increased by proper foot exercises.[16-22] While the early movements are reflex, the later are conscious and the final result of physical education is the perfect control of each muscle group.

Physiology. — As early as 1895 Wilhelm Roux[23] formulated the "Law of Functional Adaptation" modified by Lange, for the functional and anatomic changes taking place in the muscles under varying stress. Their observations were verified and extended by Duchenne, Magnus, Leo Mayer, Wacholder, and von Bayer.[20-21-22-23-24] For this analysis, the following concepts are of great practical interest:

1. Every muscle not receiving proper stimuli for contraction becomes inactive, wastes and loses elasticity. This indicates the importance of regular muscular exercise.

2. Every muscle maintains its optimal tone in midposition between maximal contraction and extension. Thus exercises involving the two extreme positions guarantee adequate muscle tone.

3. Every muscle maintaining postural innervation without relaxation undergoes metabolic and irreversible anatomic changes. Varied exercises requiring increasing and decreasing tone counteract muscular stiffness and tiredness.

4. A muscle working for a fixed period with equal contractions does not change the number of muscle fibers and is trained for maintaining permanent tone.

5. A muscle working for a fixed period with steadily increasing power of contraction due to increased resistance increases the number and volume of muscle fibers and is trained for powerful maximal contractions. Muscular exercises requiring increased contraction to overcome increased resistance are the most useful corrective foot exercises, while those which act within

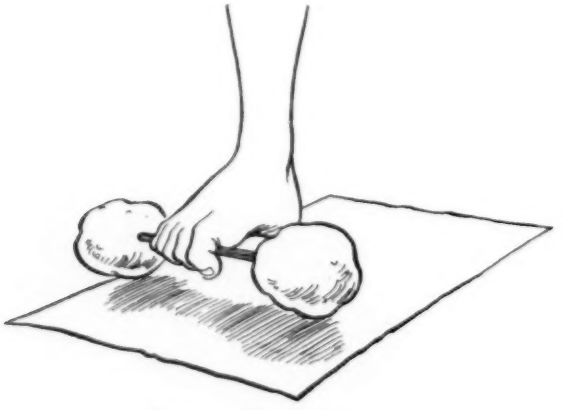

Fig. 11. — Dumb-bell exercise.

a limited range of contraction maintain postural tone as an involuntary mechanism against the force of gravity without having corrective value.

6. Involuntary muscles contract up to 25 to 30 per cent, while voluntary muscles shorten to 60 per cent. This concept underlies the importance of mental awareness (as described by Sister Kenny) for a better output of muscular energy. The muscle without mental guidance is deprived of its main stimulus and yields earlier to the harmful influence of gravity.

7. One muscle never acts alone; each muscular contraction causes relay-like functioning of a kinematic chain (von Bayer) for maintenance of body balance. The muscle in need of corrective exercise should first be exercised alone. General postural exercise for maintaining body balance and general tone should follow.

Functional Exercises

The aim of functional exercises of the foot is the restoration of optimal tone in the muscles, which will guarantee maintenance of the arches, prevent a give in the mechanically weak structures and strengthen the grasping power. Applied fully in the beginning of the walking period and maintained throughout school age, in many cases of weak feet, they make the wearing

of plates unnecessary. Sometimes use of a functional "exercise sandal" helps to hasten correction. The exercises should be carried out at least twice daily for five to fifteen minutes, each exercise being performed three to six times. We have tried by using a game-like type of exercise to eliminate monotony and to stimulate the child's ambition to attain increased muscular skill and endurance.

1. *Envelope Exercise* (*fig. 9*). — A turkish towel, 10 to 15 inches, is cut from the middle of its four sides almost to the center, so that a four leaf clover results. Underneath each corner one glass bead is fixed. Sitting on a low chair with the knee bent, the child grasps one corner after the other, bringing them to the center of the towel; then, grasping the center, the foot carries the towel to the opposite foot, which unfolds it, folds it together again and carries it to the first foot, which performs the same exercise. After a few weeks, a larger towel is used and bigger glass beads are attached.

2. *Marble Exercise* (*Partner Game, fig. 10*). — An open box containing small marbles is put to the outside of the right foot, and the marbles are carried to the empty box outside the left foot, and vice versa, with the corresponding foot carried back. After a few weeks the size of the marbles is increased and the box is put farther away. A partner can sit opposite and compete in rapidity and skill.

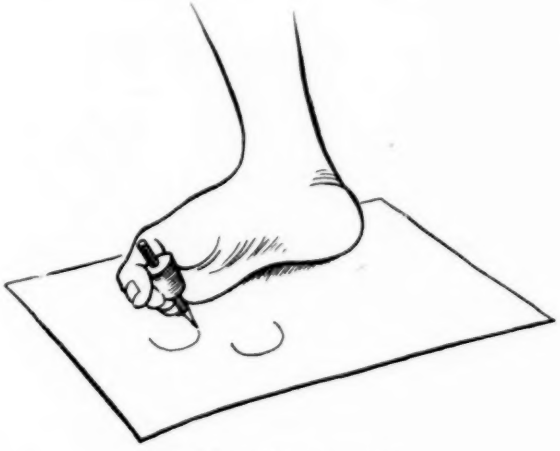

Fig. 12. — Writing exercise.

3. *Dumb-Bell Exercise* (*fig. 11*). — A small potato or a clay ball is stuck on each end of a pencil, which is lifted with the curled toes, swung several times in a perpendicular plane (with the foot in marked inversion) and then carried to the outside of the opposite foot and put down horizontally on the ground. The opposite foot performs the same exercise and carries the dumb-bell back to the original place. The size of the potatoes as well as the range of motion should presently be increased.

4. *Writing Exercise* (*fig. 12*). — A short pencil is stuck into a cork to serve as a writing gadget. It is used with the toes in maximal flexion for describing semicircles and similar figures requiring supination position. The cork at first is of medium size; a smaller cork and a slanting writing surface requires more muscle effort.

These exercises, for which a claim of originality is not made, can be varied and supplemented by similar exercises. It must be pointed out that all exercises should be done with the sole in contact with the ground, because only this causes maximal toe flexor action, and with the patient in a sitting position with the knees in right angle. Other foot exercises are tearing and compressing tissue paper, playing with bottles or Indian clubs, and walking in shoes which are too large and so require maximal toe action to lift their soles.

An "exercise sandal" which follows the active correction principle of Spitzy proved to be useful (fig. 13). It has a small round button attached to

the leather sole below the scaphoid area. A leather wedge forces the heel in supination, while a small v-shaped lateral wedge along the fifth metatarsal, ending in a metatarsal ridge, favors pronation of the fore part of the foot. The sandal, attached to the foot by a continuous strap, running obliquely and transversely, is worn for a few hours daily and exercises the muscular arch preserver units and the short toe flexors. Later the exercise is made more difficult by use of a bigger button.

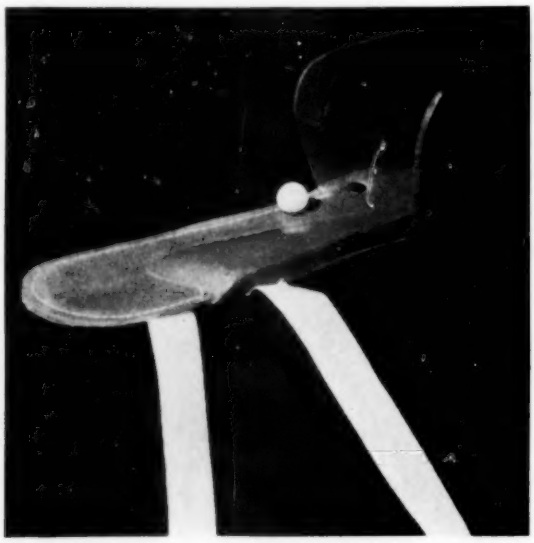

Fig. 13. — Exercise sandal with a "Spitzy Ball" and wedge for supination of heel and outer longitudinal arch wedge for pronation of fore part of foot and with "rolling off" ridge.

Conclusion

On the basis of a functional-anatomic analysis, the regaining and maintenance of the originally predominant grasping function of the human foot is stressed. According to the "laws of functional adaptation," exercises are described for the arch preserver units and the most important flexor hallucis. A lateral shift in the weight-bearing line, with primarily supinated calcaneus, is advocated, together with a rolling off plane formed by the fourth and fifth metatarsal segments running across the metatarsal arch and ending at the first and second metatarsal base, with the feet keeping in 10 to 20 degrees abduction. There should be no foot exercises without general postural exercises.

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THE TREATMENT OF FRACTURES BY PHYSICAL THERAPY *

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Early in this century, Lucas-Championnière[1] started a revolution in the treatment of fractures which is still not concluded. Dissatisfied with the nonunions and malunions resulting from the prolonged immobilization customary in his times, he was the first to advocate early removal of splints and early active motion. His studies led him to conclude that light stroking massage was sedative and relaxing to the fractured member, aiding in better reduction and hastening union. He also concluded that early active motion, assisted by the surgeon, was of prime importance in improving the functional results and shortening the period of disability. Quoting from Aristotle, he said, "Movement is life." He further remarked, "This movement plays a principal part in preservation or restoration of muscular power, in the integrity of the circulation and in the flexibility of the muscles, tendons and joints." The principles he laid down are as applicable today as when he first announced them. They are: (1) light stroking massage with no attempt whatever at pressure and (2) early active assisted motion short of pain. His maxim was gentleness above everything else.

Pathology

Fracture of a bone is followed immediately by hemorrhage, pain and muscle spasm, frequently by deformity and usually by some degree of shock. Soon, extravasation into the region begins, with more swelling and pain. The reparative process ensues early, with organization of the exudate and resorption of the hemorrhage. The adjacent bones and fragments undergo decalcification, followed by recalcification of the organized exudate and bones.

According to Magnuson,[2] the healing of a fracture is controlled almost entirely by local conditions of the tissues and within reasonable limits is little affected by the general condition of the patient. Many studies have failed to reveal any changes of concentration of the blood calcium or other constituents of the blood. Magnuson stated that a low p_H, or acid reaction, aids in decalcification, and that a change to a high p_H, or alkaline reaction, is necessary for recalcification to take place, probably owing in part to the fact that an alkaline reaction is necessary for the calcifying enzyme phosphates to become effective. The breaking down of blood clots, exudate and devitalized tissue produces an acid reaction and causes excessive decalcification of the bones.

There is another factor concerned with decalcification and calcification. According to the hypothesis of Blair, hyperemia causes decalcification and ischemia causes calcification, and the proper balance of these two factors is what maintains normal calcification of bone in health. As evidence of the decalcification associated with hyperemia, one has but to see the marked decalcification shown in bones underlying hemangioma or in an extremity suffering from an arteriovenous fistula. Lack of decalcification of bone fragments which have lost their blood supply stands out in marked contrast

* This work was done by Captain Stewart as a student officer under direction of Dr. F. H. Krusen while on assignment at the Mayo Foundation for instruction in physical medicine.

to the remaining osteoporotic bone whose blood supply is intact in cases of fracture and in cases of osteomyelitis. As is well known, a sequestrum is identified on the roentgenogram by the fact that its density is greater than that of the surrounding bone.

I should like to mention what I shall call the "hyperemia of disuse" or "hyperemia of immobilization." The roentgenologic report is usually worded "osteoporosis" of varying degree. One should not think of this as the "atrophy of disuse," as one is prone to do. The mechanism is simply one of the hyperemia of passive congestion due to loss of the milking action of the muscles on the venous return of the blood. That this decalcification of bone greatly retards the healing of fractures should be self evident, for if decalcification is the process going on, how is the callus to become calcified? The immobilization may be that applied by the surgeon or it may be a muscular splinting, acting reflexly from pain in the extremity, which may be due to inadequate immobilization by the surgeon. Here we have a reasonable explanation of so-called Sudeck's atrophy. The implication is that relief of pain and active muscular exercise starting promptly after an injury will reduce the passive hyperemia, thereby preventing the excessive decalcification and hastening union of the fracture.

The maintenance of the function of the muscles and joints is every bit as important in the functional result as is correct and prompt union of bone. The production of disability of muscles and joints is largely a result of the immobilization. Wilson[3] stated that immobilization is responsible for the "myostatic contraction" of Davenport and Ranson and thickening of the joint. Fixation of a muscle in a shortened position for any length of time results in gradual shortening of the muscle and lengthening of its antagonist. The conclusion to be drawn from these facts, is again, that as early and complete active motion as can be accomplished should be used.

Treatment

In discussing treatment I shall take for granted that the best reduction possible has been obtained.

The next consideration is that of immobilization. Jones[4] commented, "Hyperemic decalcification and ischemic recalcification of bone must be accepted as pathological facts" and, further, "If the hyperemia is perpetuated by the trauma of movement there is excessive decalcification, and a crack fracture becomes a gap fracture." We all agree with this principle. It should be followed without fail to the point of clinical union. However, it should not make us timid of mobilizing the extremity at the earliest possible time, as the disadvantage of the hyperemia of disuse will far overbalance the hyperemia produced by slight motion at the site of the fracture.

If a reduction is relatively stable it is easily maintained with a minimum of support and lends itself well to physical measures. On the other hand, those fractures which are maintained in reduction with great difficulty should not be disturbed until a fair degree of stability is obtained. One such type of fracture is that of both bones of the forearm in the middle third. Fractures of the carpal scaphoid and the neck of the femur are other outstanding examples of fractures which will not tolerate motion and should be kept immobilized.

I feel that it should not be necessary to warn against too prolonged immobilization, but one sees deformities and contractures with a history of long periods of immobilization so often that a plea for an effort to shorten the period of immobilization seems in order. Lucas-Championnière stated that immobilization prolongs pain while mobilization shortens pain and aids in the prevention of deformities.

Another aid is to change the angulation of a joint whenever possible when changing casts. I feel that the change of angulation itself is an indication for more frequent changing of casts.

Coulter[5] quoted Wright: "Institute mobilization as soon as it is safe. This is best applied by evidence of clinical union and not roentgen union. . . . Treat the patient, not the X-ray film." Too often a patient is sent to the roentgenologic laboratory with a request for "evidence of union" or of "callus," without the surgeon's even gently lifting the limb out of the cast and testing it by hand. Were such testing done, many patients suffering from fractures would be saved many weeks of unnecessary immobilization.

Lucas-Championnière practiced delicate light stroking massage to obtain relaxation and relief of pain before attempting reduction and stated that he was able to improve greatly on the reductions obtained.

It has been advocated that cold compresses be applied prior to reduction to produce ischemia and thereby check hemorrhage and prevent swelling. This measure might be worth remembering. How unusual it is for a patient to sustain a fracture when his stomach is empty. Most of mine have just finished a hearty meal. While one is waiting a suitable time for anesthesia it would be well to give morphine or codeine and apply cold compresses.

Now that the fracture is reduced and immobilized, what procedure shall we follow?

Heat. — It is recommended and logical, as Krusen[6] has pointed out, that one should not use heat over the site of the fracture for forty-eight hours, as there is danger of causing hemorrhage as a result of the active hyperemia produced. However, after forty-eight hours, heat, either from a luminous infra-red lamp or from a baker, should be applied for thirty minutes. This is accomplished by removing one-half of the plaster shell, supporting the extremity on the other half. The effect of heat is to increase the circulation through the part and hasten the absorption of the exudate and clots. Some contend that heat should never be used locally in the treatment of fractures. This contention is based on the idea that heat produces hyperemia, which in turn produces decalcification. I cannot agree with this idea, since improved circulation carries away the débris, and the benefit that this action produces is much greater than the harm that results from the decalcification of hyperemia.

Stroking. — After the thirty minutes of heat, the surgeon should personally give light stroking massage to the limb for ten minutes. This should not be delegated to an assistant or a technician, as the surgeon alone is in a position to appreciate how this particular limb should be handled. To fail in this is to invite trouble, and discredit will fall on this method of treatment.

The delicate light stroking should be applied with the relaxed hand, the fingers being held in gentle apposition and the hand molded evenly over the part with uniform contact throughout. The arm must remain relaxed, making the stroke evenly and rhythmically from the shoulder, swaying to and fro, making the strokes in one direction only. Only the lightest pressure should be made, as the effect desired is a reflex action from the stimulation of the sensory nerves in the skin. By no means should any attempt be made to "milk" the extremity, as the trauma thus produced would do more harm than good. The effect of this light stroking is a reflex hyperemia of the part and a relaxation of the muscle spasm with a marked relief from pain. If pain is produced by the maneuver one can be sure that the pressure is too great.

The light stroking should begin, like all other massage, at the proximal

end of the extremity, gradually working distally, thus progressively aiding the circulation by clearing the proximal vessels. Stroking should take about ten minutes. The half shell is replaced, the member turned and the process repeated on the other side.

Thus, heat and light massage are applied daily to every third or fourth day until union is firm enough for one to risk taking the extremity out of the splints with only manual protection. This is something, again, for which only the surgeon himself should assume the responsibility, guided by evidence of clinical union.

Active Exercise. — During this early period there is much that the physical therapy technician should do. All of the joints and muscles of the extremity which are not confined to the splint should receive as much attention as the fractured region itself. We are all familiar with cases in which a Colles' fracture is beautifully reduced and when the splints are removed the shoulder is found to be fixed in adduction. Therefore, from the beginning the technician should give light sedative massage to the affected girdle and fingers or toes and other exposed portions of the extremity. It is at this time that the patient should be exercised and instructed by the technician in exercises to be performed between treatments to maintain the function of the free joints and muscle. He should be given to understand plainly that only by his own active efforts will good results be obtained and that the treatments will merely help him to help himself.

Active exercise is the keystone of the physical treatment of fractures. If one obtains a perfect anatomic result with full range of motion of all joints and only paretic muscles to move the extremity one has less than half a cure. By starting active movements at the earliest moment and increasing the range and power of movement as fast as conditions will permit, one will improve the functional capacity of the member greatly by the time bony union is complete. If immobilization is prolonged, varying degrees of so-called mental alienation of the unused muscles appear to develop. The sense of how the muscles act is lost, and the longer the inactivity the greater is this loss. An evidence of this is the necessity of learning all over again the act of walking after prolonged confinement to bed. It is my opinion that by active use of the muscles without delay this loss of muscle sense is largely prevented.

As a corollary to this action, the use of the muscles which are not immobilized aids in retaining the function of the muscles which are immobilized, for in coordinated movements of the unaffected muscles and joints there occur reflex actions in the entire extremity, including the muscles and joints which are in the plaster cast. Thereby the patient retains the "awareness" of the extremity as a whole.

I believe a good example of this question of "awareness" and "mental alienation" is to be observed in an experiment described by Dr. Hellebrandt, in which persons were suspended in water up to the neck for some time. These subjects stated that they did not feel any sensation of the bodies at all; they felt like a head floating in space. With no stretch of the imagination, this can be carried over easily to an extremity immobilized in plaster.

The primary active exercises in the treatment of fractures are muscle-setting exercises. These should be demonstrated to the patient, and he should perform them from fifty to one hundred times daily from the third day until the day the part is liberated from the splints and free action is allowed. They serve to maintain muscle tone and muscle "awareness" and aid the normal circulation of the part. I trust the few words on this sub-

ject will help to accentuate the great importance of this portion of the treatment.

I feel that symmetric exercises of all extremities are of great importance, as an aid not only in maintaining function of the unaffected muscles but in consequently maintaining reflexes in the immobilized part.

As soon as there is sufficient union to permit temporary removal from the splints under manual protection, the assisted active exercises should be started, and they should therefore be persisted in. There should be no forced movements, as these lead to pain, muscle spasm, edema and loss of the confidence of the patient. These early active assisted exercises can be performed safely only on the specific prescription of the physician as to exactly what treatment to give.

Whirlpool Bath. — When union is firm enough the member is given a whirlpool bath for thirty minutes at temperatures from 100 to 110 F. before massage and exercise. The heat and gentle massage of the whirlpool, followed by gentle sedative massage, relax the muscles, relieve pain and ideally prepare the field for exercise. It will be found that the strength of the muscles and the range of motion of the joint are greatly increased immediately after each treatment.

Free Active Exercise. — As soon as bony union is satisfactory, the decision again depending on clinical rather then on roentgenographic criteria, free active exercise should be started. This is carried out on a horizontal powdered board or by means of some other antigravity device. It is continued until strength returns.

Active Resistive Exercise. — At this time active resistive exercise should be started, this should act against gravity, the hand of the operator or the good hand of the patient. Weights and pulleys, a rowing machine and so forth are of great value, as exercises with these are more likely to produce relaxation of the antagonistic muscles than are the simple resistive exercises. Active resistive exercise should be rapidly increased in duration and severity, as there is good evidence that strength of muscle is increased only by the extremes of exercise.

Whirlpool bath, luminous heat or diathermy for thirty minutes followed by deep sedative massage, which in turn is followed by active resistive exercise should be continued, at first daily and later every second to fourth day as long as improvement is being made. When objective improvement is no longer observed, the treatment should be stopped without delay and the patient put to work immediately on a job that will take all he can give it. The tendency is great for patients with fractures to become habituated to the treatments, and this must not be catered to. As previously mentioned, the patient must know that the treatments are only an aid and that all improvement is due to active exercise of the part.

Electrical Stimulation. — It is evident that electrical stimulation of the muscles is of little value as long as the patient retains the ability to contract his own muscles in muscle-setting exercises, for the normal action of a neuromuscular unit is far superior in all respects to an electrically stimulated contraction. When muscle setting is not possible, electrical stimulation may aid in teaching the patient how to do muscle setting.

Diathermy. — It has not been proved that diathermy has any action except that of producing heat. Its heating qualities as yet seem to offer no great advantage over cheaper sources of heat. My opinion is that it should be looked on only as an alternative source of heat until it proves a superior effect over other sources. Before using diathermy on any fracture, one should be absolutely certain that there has not been some metal introduced in an

open reduction. If there has, very bad results may occur as a result of overheating of the metal by diathermy.

Roentgen Therapy. — A word of caution on the use of roentgen therapy for nonunion must be given, even though it is foreign to our subject. Many lamentable results have been obtained. It should seem unnecessary to warn against using so powerful an agent in treating a condition whose response is so unpredictable. It should also be unnecessary to warn against using a roentgenoscope in connection with the reduction of fractures, in which procedure the bare hands of the surgeon are too often and too long in the primary roentgen ray beam coming from the tube.

Consideration of the Patient

So much for the bone, muscles, joints and capsules of the joints. How about the patient as a man? A worker in a factory or mine who sustains a fracture is projected immediately into a strange world. His proper orientation requires a fine discrimination on the part of all medical personnel.

The compensation laws have assured the injured worker adequate medical attention and hospitalization as needed. However, he gets no pay for the first week lost from work and only half pay thereafter until he returns to work. Consequently his family is likely to suffer as a result of his injury, and it is of utmost importance to see that the reaction to injury is guided into proper channels. In the armed forces the problem takes a little different angle, but the basic considerations are primarily the same.

A frank discussion of the injury, what can be expected from treatment, how long the patient will be disabled and what after-effects may be expected is his just due and will assure cooperation instead of vague fear and distrust. An early understanding of his condition will place him in a position to help himself and relieve him of his bewilderment by the vagueness of this thing of which he has no knowledge.

Grouping (Isolation From the Sick). — Kennedy[7] has worked out a common sense plan. He puts his patients suffering from fractures in a separate ward, where there are no sick people. He maintains an air of health and well-being by every possible device. Every day a technician gives the entire ward group exercises to the accompaniment of phonograph music. Each patient takes as much of the exercise as his condition will permit. At first the patients are a little timid, but soon the exercise becomes a game and they train each new recruit with enthusiasm. As far as possible each one is given some form of work to do, from folding gauze on up, and each develops a sense of responsibility for the proper conduct of the ward. Thus, instead of introspection and selfpity, they maintain a proper perspective of a human community.

Occupational Therapy. — As long as the patient is in the hospital or under active treatment at the office he feels that he is getting somewhere. But the day that his physician dismisses him and tells him to "drop in sometime and let me see how you are getting along" is a sad day for all concerned. The patient usually sits around home until the other members of the family tire of him or he tires of them (about two days). Then he drifts out to the corner store or barber shop, where he gets expert advice from all he meets. Often he thus descends into a parasitic hobo attitude from which recovery is more difficult than recovery from the injury itself.

Although there is no occupational therapy better than a return to the regular job, a well organized department of occupational therapy is of great value in preventing deterioration of such patients and aiding in their rehabilitation. Increase of muscular strength and range of motion of joints

is accomplished much more easily by interesting work than by a set of exercises. Occupational therapy is particularly well adapted to army and navy hospitals, for their patients stay in the hospital until they are fully recovered and able to return to full duty. In industrial work occupational therapy helps fill the gap between active treatment and return to work, increasing function while preventing a disintegration of the interests of the patient.

I say again, the best occupational therapy for an injured worker is prompt return to factory or mine, even if light work has to be provided for him to do. A return to his regular place of work, with regular hours of work among familiar surroundings with his fellow workmen, is a tonic without equal. It is coming home.

There is only one trouble about this plan. Too many employers will not give such people work of any kind until they are able to go back to what they were doing at the time they were injured. The injured worker feels that he is not getting exactly a square deal and wonders, with some justice, whether he ever will get his job back. This is a critical period and is productive of many unnecessary lawsuits and hearings before industrial commissions.

Economics. — It is interesting to see what the insurance companies think about the physical treatment of fractures. B. C. Kuechle,[8] of the Employees Mutual Liability Insurance Company of Wisconsin, has expressed the opinion that physical therapy definitely pays in the treatment of fractures. In the experience of his company, physical therapy was of value in 100 per cent of cases of fractures. His company has established physical therapy centers in central areas and feels that the saving caused by the lessened duration of disability and the less permanent disabilities resulting compensates it financially for doing so.

Summary

The following measures for the physical treatment of fractures are recommended: (1) radiant heat for thirty minutes followed by light stroking massage for ten minutes starting forty-eight hours after reduction, given daily to every third or fourth day as circumstances permit; (2) muscle- setting exercises after forty-eight hours, to be performed fifty to one hundred times daily until splints are removed for good; (3) active exercise of all nonimmobilized portions of the extremity and symmetric exercises of the entire body; (4) protected active assistive exercise as soon as possible; (5) whirlpool bath for thirty minutes followed by sedative massage, which in turn is followed by free active exercise, the physician being guided by clinical evidence of union and not waiting for roentgenologic evidence of union; (6) active resistive exercise daily without use of force when union is firm enough; (7) occupational therapy if possible. The patient should return to a full working day of light work as soon as possible.

Honesty and frankness with the patient from the start gain his confidence and cooperation and enable him to orient himself with the strange world into which he has been thrust so violently.

One insurance company has concluded definitely that the treatment of fractures by physical therapy is a paying proposition.

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DIAGNOSIS AND TREATMENT OF LOW BACK PAIN *

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Low back pain, like the common cold, seems to be ever present both in civilian and in military practice. The voluminous literature on this subject is mute evidence that physicians are far from perfection in the handling of this common condition. There seems to be a tendency among busy physicians to minimize low back pain, and too many patients are dismissed with only a superficial examination and a "shotgun" prescription usually containing salicylates or other coal tar derivatives prescribed on a purely empiric basis. Just why the sacroiliac joint is often accused of being the culprit is a matter of conjecture. Lay persons seem to derive considerable satisfaction from confiding to their friends that they have "a sacroiliac," and sooner or later many of them wear a self-prescribed sacroiliac belt.

Low back pain of visceral origin is surely more common in civilian than in military practice, considering the age group and the predominance of men in the army. Any obscure backache should bring to mind the possibility of intra-abdominal or genitourinary disease, and if the patient is a female a pelvic examination is warranted.

Types of Low Back Pain

There follows an enumeration of some of the common types of low back pain, with their management, in the order given by Krusen and Basom[1] in 1940.

Lumbosacral Arthritis. — The usual history in cases of lumbosacral arthritis is one of prolonged backache over the lumbosacral region which may or may not extend into the thighs. A positive reaction to the straight leg-raising test, which is known as Lasègue's sign, frequently can be elicited. The "knee-rocking test," or the "spinal rocking test," frequently gives positive results. Motion is limited and pain is produced by forward and backward bending by the patient while standing or sitting. Anteroposterior, lateral and oblique roentgenograms are likely to reveal a diminution in the width of the lumbosacral interspaces and hypertrophic changes or changes in the articular facets. Lesions situated higher in the spinal column should be considered if the roentgenogram of the lumbosacral region is normal.

Sacroiliac Arthritis. —In speaking of sacroiliac arthritis, Krusen and Basom[1] said. "Tenderness is the most common sign. Pressure on the adjacent ilium just above the sciatic notch is most likely to elicit this sign."

Motion of the spinal column, such as forward bending, is usually limited in the standing position but not in the sitting position. The "knee-rocking test" gives negative results. Gaenslen's test gives positive results on the affected side, ruling out lumbosacral arthritis. Motion may be limited in straight leg raising. Roentgenographic examination is not as much help as it is in the case of lumbosacral arthritis, but fusion, variation in width of the joint and hypertrophic or destructive changes may be observed. Muscle spasm is usually much more pronounced in infectious arthritis than in arthritis of the hypertrophic type. A history of pain after resting and pain and stiffness on arising in the morning is suggestive of infectious arthritis, while a history of pain aggravated by work is more common with the hypertrophic type of arthritis.

* This work was done by Lieutenant Stucky as a student officer, under direction of Dr. F. H. Krusen, while on assignment at the Mayo Foundation for instruction in physical medicine.

Treatment is conservative and is similar for infectious (atrophic) and for senescent (hypertrophic) arthritis of either the lumbosacral or the sacroiliac joints. Rest in bed on a firm mattress without inner springs and with a board between the mattress and springs is invaluable. The pelvis may be fixed with adhesive strapping. Traction is usually of benefit and may be applied with padded ankle cuffs or Buck's extension with 5 to 10 pounds on each leg used intermittently while the patient is awake. Occasionally the patient will not tolerate traction, and it is wise not to enforce this measure too strongly. Infra-red irradiation and massage alternated daily with local diathermy and massage are used during the period of rest in bed. With supervised conservative treatment, maximal benefit should be obtained in ten to fourteen days, after which a supporting belt or corset may be fitted. Krusen and Basom[1] said: "Men prefer a heavy belt. Women prefer a corset. Fitting is more important than the type."

Postural Strain. — Postural strain is common among obese persons. The heavy abdomen causes a constant drag on ligaments, thus producing postural backache. Thin persons with poor musculature who stand with round shoulders and marked lordosis are good candidates for postural strain, as are young persons with the round shoulders of adolescence. Finally, there are persons with conditions in which faulty posture may play a part. In this group are those with skeletal abnormalitits conducive to poor posture. The "dystocia dystrophia" type are in this class.

The majority of patients with postural strain have a tendency toward increased lumbar lordosis and thoracic kyphosis. Postural training is the most important treatment. Pain may be of sufficient severity to justify the conservative measures used in lumbosacral or sacroiliac arthritis. The lumbar curve may be reduced by exercise of the abdominal muscles. Exercise in the prone position, the upper part of the trunk and the head being raised without assistance of the upper extremities, will help straighten the thoracic kyphosis. In spite of supervised postural training and exercise, satisfactory improvement can be obtained only by the daily use of self correction for a long time.

Spondylitis Deformans. — Diagnosis of spondylitis deformans is dependent on early rigidity of the spinal column and a decreased thoracic expansion. Roentgenographic examination may show calcification of ligaments or fused sacroiliac joints.

Krusen[2] said: "Prevention of deformity is the most important point in management." Elimination of any foci of infection is an adjunct to treatment, not, however, with any anticipation of a spectacular remission of symptoms. Rest in bed may be necessary during the painful stage, and proper measures should be used to prevent development of kyphosis. A strong brace with shoulder straps should be used to support the spinal column when the patient begins to stand. Diathermy or infra-red irradiation followed by massage is of benefit if used for a long time. Thoracic expansion is improved with deep-breathing exercise. Head traction followed by the application of a Thomas collar may be necessary if the cervical portion of the spinal column is involved.

Contracted Iliotibial Bands (Ober's Disease). — Contracted iliotibial bands may be found in some instances of low back pain and frequently with sciatica. A lateral deviation of the spinal column to the affected side will be observed if the condition is unilateral, and lumbosacral strain will be present if the condition is bilateral. Ober's test gives positive results on the affected side.

Conservative treatment should be tried first. An attempt should be made to stretch the fascial bands by active and forcible passive exercise and postural exercise. Adhesive strapping may be used to help relieve tension on the tight

bands. If a fair trial of conservative treatment does not give relief, Ober's fasciotomy is recommended. The incision is made from just below the iliac crest to the greater trochanter. The fascia is exposed from the anterior-superior iliac spine backward to the edge of the gluteus maximus muscle and then divided transversely at its region of greater contracture, which is from the anterior to the posterior landmarks.

Senile Osteoporosis. — Backache may occur among elderly persons as a result of osteoporosis. It usually is accompanied by other evidence of senility. Severe pain and kyphosis are the common findings. Roentgenographic examination reveals the osteoporosis and changes in the intervertebral disks, but it is somewhat of a paradox that the same roentgenologic findings occur in some cases in which symptoms are absent.

Treatment consists of relief of pain, prevention of further deformity and promotion of recalcification of bone. Rest in bed may be necessary for relief of pain in some cases but should be discontinued as soon as possible. Some form of support or back brace is of benefit for the ambulatory patient, but care must be exercised to pad the bony prominences. Local heat and massage will increase the circulation, and sun baths or ultraviolet irradiation promotes the absorption of calcium. Oral administration of 1 drachm (4 Gm.) of tribasic calcium phosphate three times daily with some form of vitamin D is beneficial. No spectacular results should be promised the patient. The period of treatment is long, and temporary symptomatic improvement will cause many patients to discontinue therapy prematurely.

Posterior Protrusion of an Intervertebral Disk. — Although herniated intervertebral disk or herniation of the nucleus pulposus has become a rather common diagnosis, there are still a large number of cases of so-called sciatica in which soft tissue or myofascial injury is responsible for back pain and sciatic pain.[3] This myofascial syndrome and the strictly reflex sciatic extension of the pain must be distinguished from the sciatic pain caused by a herniated disk.

I believe it is in order at this point to digress from a strict discussion of herniated disk, which produces sciatic pain, to a consideration of the differential diagnosis of this type of pain from sciatic pain of reflex origin. Pain impulses travel from a peripheral point, such as strained soft tissues of the back, centripetally to the spinal cord and make synaptic contact with other sensory units at different levels and distribution, with the result that pain is sensed in the second unit. The reflex character of the pain in some cases of sciatic pain can be proved if the reflex arc can be interrupted at its point of origin, in this case a lesion of the soft tissues of the back. Frequently patients suffering from low back pain have "trigger points," small localized areas of pain on pressure. The more common trigger areas are over the lumbosacral junction, the posterior superior iliac spines, the gluteal insertion at the outer posterior rim of the ilium and the posterior border of the tensor fasciae femoris. These structures receive their sensory innervation from the posterior primary division of the lower lumbar and sacral nerves. The sciatic trunk, on the other hand, is composed entirely of the anterior primary divisions of the spinal nerves. Communication does not exist between the anterior and posterior primary divisions, and any synaptic connection between the two units must occur not lower than in the spinal ganglions or, more likely, in the lateral horns and spinothalamic pain-conducting tract of the cord itself.

Five to ten cubic centimeters of 1 per cent solution of procaine hydrochloride injected into one of the trigger areas will abolish the sciatic pain if it is of reflex origin. This indicates that the sciatic pain is not due to direct involvement of the nerve root, as in cases of herniation of an intervertebral disk. Reflex sciatic pain is not accompanied by paresthesia, anesthesia or changes in the

deep reflexes, and there is no strict anatomic distribution of the pain, as in cases of herniated disk. The presence of paresthesia strongly indicates organic involvement of a nerve root.[3]

On physical examination of a patient with a herniated disk, spasm of the erector spinae muscles with a list toward the affected side may be observed. Limitation of motion and pain are produced by forward bending. Pressure with the thumb in the paravertebral space between the iliac crest and the lumbar vertebrae on the affected side reproduces or increases the pain. The straight leg-raising test is positive in most cases. Coughing and sneezing exaggerate the pain in the majority of cases, and in some cases Naffziger's test gives positive results. The knee reflexes are commonly equal, but the achilles tendon reflex on the affected side is diminished or absent.

Hyndman, Steindler and Wollin[3] reported 50 cases in which herniated intervertebral disk was found when laminectomy was performed. In 46, the herniated disk was situated below the fourth or fifth lumbar vertebra. In these cases, low back pain had been present for two months to twenty years before operation was performed. The usual duration of the pain was two or three years.

In 27 of 36 cases in which a history of injury was obtained, extension of pain down a lower extremity occurred two days to fifteen years after low back pain first was observed. This usual period was weeks or years.

In all of the 46 cases, the pain extended down the posterior aspect of the thigh, and it usually involved the lateral aspect of the calf. In 33 cases, the pain involved the ankle or the dorsum or ball of the foot.

Some form of paresthesia was present in 39 cases. In 17, the concentration of protein in the spinal fluid was greater than 45 mg. per hundred cubic centimeters.

Hyndman, Steindler and Wollin agreed with Dandy[4] that the intraspinal injection of iodized oil is not necessary to make a diagnosis in most cases of herniated disk. They did say, however, that there are equivocal cases in which every means should be employed to make a diagnosis.

Operation generally is considered the treatment of choice; however, if operation is refused or if the patient is a poor surgical risk, conservative measures, including use of radiant heat, massage and a spinal brace, may be of benefit.

Breck and Basom[5] stated that "flexion treatment" may be utilized in cases in which low back pain is the result of narrowing of the fourth or fifth lumbar disk, regardless of whether the pain is due to subluxation or to posterior protrusion of the intervertebral disk. According to Barr and Mixter,[6] conservative treatment is indicated in every case of suspected protrusion of an intervertebral disk unless there is obvious pressure on the sensory nerve root as shown by objective sensory or motor disturbances. Farrell and MacCracken[7] said that "the need for laminectomy in treating protruded disks has never been established." Danforth and Wilson[8] in describing the pathologic anatomy of narrowing of the lumbosacral or fourth lumbar disk said that it caused a decrease in the size of the foramen of the exit of the nerve and irritation of the nerve root. Ghormley[9] said that narrowness of a disk was a basic pathologic change and that for several years it had been recognized by some writers as a clinical entity.

Conservative flexion treatment[5] consists of putting the patient in bed in a hospital. The back rest should be raised to an angle of 45 degrees, and the knee rest should be raised almost as far as it will go. Patients may be treated at home with an improvised back rest and knee support. Satisfactory treatment consists of having the patient maintain the flexed position for two hours three or four times daily and lie on one side with the knees drawn up the rest

of the time. In addition, the use of radiant heat or diathermy with massage helps to alleviate pain and muscle spasm. Flexion exercises should be started the first day. The knees should be pulled up to the thorax with the spinal column flexed, and the neck and thorax should be brought well forward, six times daily. At first this exercise should be employed only once on each occasion, that is, six times daily, but the number of exercises should be increased gradually until ten are being taken on each occasion. The patient usually is able to be up and about in three to seven days. The most important part of the treatment is to impress the patient with the importance of flexing his lumbar segment of the spinal column and keeping it flexed. Many patients certainly deserve a trial of conservative treatment before being operated on.

Spondylolisthesis. — Pain, stiffness and weakness in the lower part of back, sacroiliac region, hips and legs are the principal subjective symptoms of spondylolisthesis. The grooved lumbar position of the spinal column and prominent spastic erector spinae muscles with shortening of the torso and lordosis are found only in cases of advanced spondylolisthesis. Roentgenograms will reveal the abnormality.

Spinal fusion is indicated in many cases; however, in a large number of cases the symptoms are mild and conservative treatment should be given a trial. Such treatment should also be tried if the patient refuses operation. Traction is used in an attempt to reduce the deformity, and a plaster cast may be used for fixation. A "rocking chair belt" [10] gives the necessary support for ambulant patients. Radiant heat and sedative massage are utilized to relieve pain and muscle spasm.

Coccygodynia. — Coccygodynia caused by spasm of the levator ani, coccygeus and piriformis muscles is often mistaken for coccygeal injury, sciatic neuritis, intrapelvis lesions and lumbago. In coccygodynia there is "a vicious cycle of pain, muscle spasm, more pain and more spasm." [11] The patient tends to walk stiffly and to sit on one buttock. Sitting increases the symptoms. The possibility of a neurosis or arthritis of the lower part of the back must be ruled out.

Application of radiant heat to the lower part of the back, including the coccygeal region, followed by massage and postural exercise, is of benefit. Thiele's technic of internal massage per rectum relieves symptoms in many cases. Excision of the coccyx should be postponed until conservative treatment has been tried for several months.

Fibrositis. — This condition is a primary infectious chronic inflammation of white fibrous tissue of fasciae, aponeuroses, sheaths of muscles and nerves, ligaments, tendons, periosteum or subcutaneous tissues. Common situations for the induration are the occiput, posterior cervical muscles, erector spinae muscles, crest of the ilium (anterior and posterior), tissues over the sternum and costal cartilages. The usual signs of fibrositis are palpable induration, fibrous thickenings and nodules in the muscles or fasciae, associated with tenderness, swelling and muscular hypertonicity. The common subjective symptoms are muscular and periarticular pain and stiffness, particularly morning stiffness and "jelling" (stiffness after a period of inactivity), fatigue, aching and lassitude.

Physical therapy, consisting of the use of radiant heat and firm friction massage applied directly to indurated regions, plus adequate rest, plays an important part in the treatment. Rosenow's fibrositis vaccine seems beneficial in some cases.[12]

Miscellaneous Conditions. — This group includes some of the less common conditions causing low back pain and some requiring special consideration.

Fractures of vertebrae[13] are treated by hyperextension of the spinal column, and early application of a half cast makes possible the early employment of heat

and gentle massage, which promote relaxation and hasten a return to anatomic normal.

Tuberculosis of the spinal column, undulant fever and neoplasm, while not common, should be considered in cases of otherwise unexplained low back pain. Physical measures are indicated in the treatment of each of these, even in neoplastic conditions, as Krusen[14] has stated "in hopeless cases of malignancy heat and even light massage as palliative measures may be administered with justification."

Partial sacralization of the fifth lumbar vertebrae may produce symptoms. Repeated minute injuries may occur at the site of contact and produce traumatic arthritis with considerable pain. Heat and massage may produce symptomatic relief. There is no trauma or pain with complete sacralization.

Alterations in the articular facets of lumbar vertebrae may cause pain. Some of these are revealed only by oblique roentgenograms. Postural exercise to extend the spinal column may be of some benefit.

Hypertrophy of the ligamentum flavum is a rare condition that may cause low back pain. Operation is necessary for relief. Physical therapy is not indicated.

Psychogenic backache belongs in that small group of conditions in which, although not recommended, the treatment of choice would be to send the patient to one's enemies. The symptoms are usually a defense mechanism in a constitutionally inadequate person. Any therapy is ineffective until the psychologic background is clarified.

In military practice one finds a surprisingly large number of patients complaining of backache that does not fit neatly under any of the mentioned headings. Many of these no doubt have psychogenic backache, but many are plain malingerers. I believe that the great variation in the pain threshold is a possible explanation in a high percentage of cases. Mild lumbosacral strain, mild fibrositis and even minor trauma are taken as a matter of course by some more stoic persons, while these may be very real to a person having a low pain threshold.

Conservative Treatment

Many patients with low back pain for which conservative treatment is indicated are admitted to the Station Hospital at Camp Shelby, Miss. A fairly successful routine treatment has been devised, as follows: (1) rest in a firm bed; (2) use of two pillows under the knees while the patient is lying in the supine position; one or no pillows under the head; knees flexed when the patient is lying on his side; (3) application of hot, moist compresses to the back for thirty minutes three times daily; (4) administration of salicylates in doses of 30 grains (2 Gm.) three times daily, with gradual reduction of the dose; (5) bathroom privileges only two times daily; no walking out on porches to smoke; (6) traction to insure rest in bed and aid in relaxation of muscles (always used with pillows under the knees), and (7) postural training with baking and massage as soon as the patient has become comfortable in bed.

Comment

With the exception of hypertrophy of the ligamentum flavum, conservative treatment is indicated, or at least a trial of conservative treatment is indicated, for each of the conditions considered.

Conservative treatment in practically every case consists largely of physical therapy.

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Treatment of Fractures by Physical Therapy — Stewart

(*Continued from page 33*)

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MARCH FRACTURE

A Common Disability of the Foot in Military Practice *†

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Busy army physicians conducting the routine sick call or similar physical examinations in hospitals hear many complaints about feet. The incidence of such complaints may run as high as 40 per cent of all complaints. They are frequently confronted with the condition designated "march fracture," "march foot" or "insidious fracture." This is a common and definite clinical entity consisting of spontaneous fracture of the shaft of one or more metatarsal bones without history of trauma.

History

In 1855 Breithaupt,[1] a Prussian military surgeon, described several cases of swelling and pain in the feet in soldiers following forced marches. He expressed the belief that the condition was a traumatic inflammatory reaction in the tendon sheaths. He designated it *Fussgeschwulst*, or swollen foot. In 1877 Weisbach[2] described this condition and considered that the lesion affected the ligaments and not the tendon sheaths.

In 1887 Pauzat,[3] a French investigator, attributed the condition to rubbing by the dorsal fold of a government-issued shoe over the metatarsal region. This rubbing, he considered, caused swelling of the soft tissues followed by periosteal proliferation which resulted in definite osteoplastic periostitis. Later he suggested a "rheumatic diathesis," which hypothesis is in keeping with the modern trend of thought. In 1891 Martin[4] suggested synovitis as a possible causative factor.

In 1897 Stechow,[5] after the advent of roentgenology, exploded these older hypotheses by demonstrating that the lesion was due to a definite fracture of a metatarsal bone. Schulte[6] confirmed this observation in the same year.

In 1921 Deutschlaender[7] suggested bacteria as an etiologic factor. He reported several cases of low grade fever and hematogenous bacterial periostitis with callus formation. In 1928 Goldman[8] described the first case in this country accurately. Numerous other articles, voluminous with etiologic theories, have been written on the subject,[9-10-11-12-13-14-15-16] the earliest coming principally from German and French physicians.

Henschel[17] ascribed the high incidence of march fracture in the German and Swiss armies to the forced rigid cadence used in marching, especially on parade and on hard pavement. In contrast, the less rigid gait of the Italian and French soldiers is less damaging to the bones and joints. The American soldier has been forced to undertake intensive marching periods, physical education and training on obstacle courses with fundamentally weak feet wholly unconditioned to the imposed stress. The lowered muscle tone of the feet of the average American youth is perhaps due to extreme fashions in footwear and overdeveloped transportation systems. The frequency of march fracture among American soldiers in wartime is due also to the induction into the army of thousands of sedentary workers who are thrown suddenly into vigorous training exercises.

* This work was done by Captain Bosshardt as a student officer, under direction of Dr. F. H. Krusen, while on assignment at the Mayo Foundation for instruction in physical medicine.

† Read at the seminar on physical medicine, Mayo Foundation House, July 27, 1943.

For years this fracture was thought to apply to conditions in the armed forces alone, but recently it has been found among civilians engaged in occupations that require constant heavy lifting or long standing; for example, among nurses, waitresses and shop assistants. It has even been observed in pregnant women.

Etiology

Jansen[18] in 1926 suggested that there is spasm of the interossei muscles which leads to hypertrophy of the muscle tissue and periosteum. Subperiosteal hemorrhages follow, resulting in partial absorption of bone with increase in its brittleness and susceptibility to fracture. He substantiated his claim by showing that periosteal changes were never noted on either outer border of the fifth or first metatarsal bones, the only regions from which the interossei muscles do not arise.

Sloane and Sloane[19] stated that flat feet led to secondary disturbance of circulation of the blood and increased brittleness of bone.

Morton[20] gave four causative factors: 1. The first metatarsal bone is shorter than the second according to measurement on roentgenograms. 2. The first intermetatarsal joint is prolonged backward. 3. Posteriorly situated sesamoid bones at the head of the first metatarsal bone have the effect of shortening it. 4. The first three factors lead to compensatory enlargement of the shaft of the second metatarsal bone; but if hypertrophy is inadequate and prolonged strain is applied, fracture is likely to result.

In a somewhat similar theory Brandt[21] suggested that the etiologic factor of the fracture is in the torsion mechanics of the foot, which may cause its acute sinking. Under stress of marching the medial aspect of the foot gives way and bends upward; pronation of the whole foot and inward rotation of the talus and malleolus follow. Weight bearing is thus shifted to the heads of the longer and thinner second and third metatarsal bones, and the most traumatized one is the first to break. Several may be affected simultaneously or successively; one or both feet may be involved.

Meyerding and Pollock[22] in the latest review of this fracture from the Mayo Clinic stated: "Perhaps the most accepted view is that of Zeitlin and Odessky, who concluded that march fracture occurred as a result of overloading a foot already weakened functionally and anatomically. The number of hypotheses advanced to explain this condition indicates the uncertainty which still shrouds its origin." They expressed the belief that inflammatory factors account for a small proportion of cases. Neurogenic influences must also play a part.

Pathology

Henschel's observations, confirmed by Krause's,[23] distinguish four stages of the pathologic process of bone taking place at the site of fracture:

1. Periosteal neuralgia, or stress pain, first occurs seven to ten days after the initial symptoms, and a definite fracture line is difficult to demonstrate. 2. About two weeks later a loosely calcified, fuzzy, spindle-shaped callus is often noticed around the shaft of the second or third metatarsal bone in the roentgenogram. This may resemble an ossifying or rarefying type of osteitis, with tissue densities or clearings or cracks due to bone resorption. It may be termed "a severe exhaustion process of bone." A definite thin line of fracture may or may not be demonstrated now. 3. A later roentgenogram, in approximately two weeks, reveals a definite line of fracture, with callus appearing more dense but with evidence of advanced bony resorption. 4. In the final stage, several months later, a slight thick-

ness of the bony cortex is the only remaining sign of this spontaneous fracture.

Meyerding and Pollock[24] stated that periosteal proliferation is due to irritation at the site of fracture and is a result of imperfect immobilization with superimposed repeated minimal trauma.

Histology. — Brandt[21] has shown conclusively that a bony destructive process with fissure formation, necrotic bone, detritus and signs of regeneration exists, as is seen in newly formed callus.

Symptoms and Diagnosis

Symptoms. — The onset is usually is usually insidious, without any definite history of trauma. Often the pain is trivial for four to six weeks, and it can easily be endured by the soldier until a sudden intense pain occurs and necessitates hospital care. A definite limp may now be evident. There is burning or aching pain in the forepart of the foot, usually pointed to the dorsum of the foot for localization. There is usually some swelling on the dorsum, with localized tenderness and edema and often increased temperature of the skin over the part involved. At this stage the condition may be confused with nonsuppurative cellulitis. The pain is relieved by absolute rest, elevation of the part and avoidance of weight bearing and marching. Pain increases on flexion of the involved metatarsal joint. The pain is progressive unless rest is instituted.

Differential Diagnosis. — The pertinent questions asked by most observers are: 1. Is it really a fracture or tumor? 2. Is it inflammatory, infectious or traumatic? 3. Which comes first, fractures or periosteal proliferation?

March fracture can easily be confused with acute nonsupurative tenosynovitis, with a malignant process, such as Ewing's tumor or osteogenic sarcoma, or with syphilitic periostitis. Biopsy should be done whenever indicated. It is all important in the presence of systemic symptoms, such as loss of weight and night pain, when doubt exists concerning the condition. Flocculation tests will exclude syphilis. Progressive swelling, superficial pain, tenderness and local elevation of the temperature in the absence of any abnormality in the roentgenograms are indicative of tenosynovitis.

Diagnosis. — Pain in the feet relieved by rest or elevation among young unseasoned recruits, or this condition following long forced marches or exercise without a definite history of trauma and with roentgenologic evidence of periostitis or an early fracture line in the shaft of the second, third or fourth metatarsal bone, is conclusive evidence of march fracture. Other metatarsal bones are rarely involved.

The fact that fracture is not always seen at first is no criteria for its absence. Watson-Jones,[25] the English surgeon, pointed out that similar fractures occur elsewhere in the body, particularly in the scaphoid bone of the wrist.

Prognosis and Treatment

Prognosis. — The outlook is always good. In six to eight weeks the callus over the site of the fracture has become firm and dense, and in four to six months only residual thickness of the bone shaft, without deformity, is evident. The patient is usually able to stand full duty in six to ten weeks.

Treatment. — Rest is of paramount importance. Immobilization with or without a plaster cast for three or four weeks should be employed. Physical treatment should follow for about two weeks. It may consist of locally applied heat, daily whirlpool baths and light massage followed by foot-strengthening exercises for dorsal and plantar flexion at the metatarsophalan-

geal joints. Because of the possibility that a vitamin deficiency is the underlying cause of spontaneous fracture, the patient should be given a diet high in vitamins plus multiple vitamin therapy. Proper shoe adjustment should be made to correct an abnormal weight-bearing line in the body. Roentgen examination should be repeated to determine the extent of callus formation and healing before full military duty is advised.

Comment

I am in accord with the view of investigators who have concluded that the fracture is primary and is related to a preexisting static disturbance of the foot, on which, rhythmically repeated subthreshold mechanical insults have been acting. I wish to stress the need for prevention and when that fails for early recognition, more perfect and frequent roentgenograms in all planes and early treatment.

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EDITORIALS

PHYSICAL MEDICINE 1943-1944

A PROSPECT AND A RETROSPECT

It has been often said that the only good thing medically that come out of World War I was the first real appreciation of physical therapy by the medical profession for its aid in restoring the injured and disabled. This appreciation together with the simultaneous development of many new physical treatment agents, such as diathermy, ultraviolet and the whirlpool bath, led to the present day advanced position of physical medicine in the United States. The new global conflict, with its tremendous casualties, focuses attention again on physical therapy, and as we take stock of its present status at the end of the second year of warfare considerable satisfaction can be derived from some of the recent progress and much confidence gained for the future outlook of our discipline.

In the progress of methods and application there were no such spectacular developments as at the time of World War I, but there occurred rather a reaffirmation and more careful study and application of some well known but so far neglected physical therapeutic principles. Among these were the use of hypothermy, or treatment by cold, the acceptance of ultraviolet irradiation for air sterilization, the final experimental corroboration of the value of electric stimulation of muscle in peripheral paralysis and the increasing use of electric shock treatment in depressive mental conditions, including those formerly misnamed shell shock. The Kenny method for the early treatment of infantile paralysis has greatly enhanced the appreciation of the early use of physical agents in paralysis and led to attempts to apply its principles to other orthopedic conditions. Modern methods of exercise and reconditioning, and the correlation of occupational therapy with physical therapy received much attention.

The value of physical treatment methods as a whole for the early treatment of war-connected disabilities has been fully recognized by the armed services; physical therapy departments have been moved forward from base and general hospitals right into station and field hospitals; intense training programs are being carried out to staff these departments adequately with medical officers and technicians. About sixty new members were added to the roster of the fellows of the American Congress of Physical Therapy at its September meeting, a great many of these being medical officers recently trained in physical medicine. Physical therapy has been accorded a place in the program of wartime graduate lectures given all over the country in service hospitals. Spa treatment as a link between physical restoration and reconditioning has been recognized for the first time in the United States, and centers of rehabilitation were established by the Army, Navy, and Veterans Administration at many renowned resorts.[1]

Added to these advances in the actual practice and teaching of physical medicine were the recent developments in its study, as pointed out in the ARCHIVES last month.[2] Most significant and potentially most important among these is the establishment of the Baruch Committee on Physical Medicine.

Based on these encouraging events of the near past, the immediate as well as the remote future looks bright for the cause of physical medicine. The results of large scale clinical work will serve to convince the medical profession and

the disabled service men and their families that physical therapy is an essential part of routine medical care and must therefore be included under a proper set-up in the work of all hospitals. The large number of young physicians trained will be eager to continue and further develop their work in physical medicine as shown by a number of contributions in this issue of the ARCHIVES.[3, 4] The work of physical reconstruction carried out in health resorts will set a standard for future more intelligent and more widespread work for civilians than heretofore and should offer new opportunities to well trained physicians and technicians. Clinical and laboratory work will be carried on in an increasingly large number of centers and more undergraduate instruction be established in medical colleges. Finally it may be confidently expected that the results of the survey about to be published by the Baruch Committee not only will become a powerful stimulus for the nationwide recognition of the potentialties of physical medicine but also will mark a milestone in the effective solution of some of its most urgent problems.

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THE PLIGHT OF THE MANUFACTURERS

The maintenance of the health of the civilian population is an urgent need even in the midst of a total war, so that our people may be able to submit cheerfully to the sacrifices required from all. Physical therapy apparatus has become a recognized need for treating certain types of injuries and disabilities among the armed forces as well as among the civilian population. But there is a curious contradiction in the order of the War Production Board to stop the manufacture and sale of apparatus for physicians and permit it only for the military establishments.

Manufacturers of apparatus find themselves in a sad plight nowadays when physicians clamour even for replacement of such parts as radio tubes and electrodes for short wave apparatus, for infra-red burners for heat lamps and for other urgently needed service to keep their apparatus going. At the same time the filling of war orders economically is impossible without quantity production. How can a manufacturer whose plant lies idle fill driblets of orders of six to ten pieces of apparatus when he has no stock of parts on hand?

It would be most desirable and would directly aid the fulfilment of war needs if the stringent restriction on allocation of material for medical apparatus were modified as it was rumored some time ago. We must sympathize with the present position of our manufacturers, most of whom have stoutly cooperated for many years to anticipate and fill our needs.

We need the maintenance of established high grade manufacturing organizations to be ready to fill the urgent needs of the postwar period in an adequate and ethical way. We remember much of the damage done by irresponsible high pressure salesmanship after World War I, and the more recent havoc by a crop of "fly by nights" in the high frequency apparatus field which seriously endangered the proper development in that line.

Let's appreciate the present plight of our old friends the manufacturers, and do all we can to help them.

1944 SESSION — CLEVELAND, SEPTEMBER 6 TO 9

The twenty-third annual scientific and clinical session of the American Congress of Physical Therapy will be held in Cleveland, Ohio, on Sept. 6, 7, 8 and 9. Because of the increased use of physical therapy as an important step in rehabilitation in the armed services and also in civilian practice this meeting should be of interest to many physicians.

The program committee has begun on setting up the program. Eminent speakers from the Army, Navy, Veterans Administration and Public Health Service will be invited to present papers on the use of physical therapy in these services. Physical therapy in general practice will also receive adequate attention, as well as special subjects.

As usual the instruction seminar will be presented during the session. Each year these instruction courses have become more popular. The course committee will put forth every effort to give a good variety of subjects which will be instructive and practical. Watch for future announcements and schedule.

MEDICAL NEWS

Committees for 1944

American Congress of Physical Therapy

Advances in Education

Earl C. Elkins, M.D., *Chairman.*
Frances Baker, M.D.
Robert L. Bennett, M.D.
William Bierman, M.D.
Catherine West, M.D.

Constitution and By-Laws

John S. Coulter, M.D., *Chairman.*
Frank H. Ewerhardt, M.D.
William D. Paul, M.D.

Cooperation With Army, Navy, Public Health and Veterans Administration

Frank H. Krusen, M.C., *Chairman.*
*Everill Wm. Fowlks, M.D.
*O. Leonard Huddleston, M.D.
*H. Worley Kendell, M.D.
*Louis B. Newman, M.D.

Finance

Frank H. Krusen, M.D., *Chairman.*
Frank H. Ewerhardt, M.D.
Roy W. Fouts, M.D.

Legislation

Milton G. Schmitt, M.D., *Chairman.*
William Northway, M.D.
Jessie Wright, M.D.

* In active service.

Medical Economics

Madge C. L. McGuinness, M.D., *Chairman.*
William D. Paul, M.D.
B. S. Troedsson, M.D.

Meeting Place

Walter J. Zeiter, M.D., *Chairman.*
Richard Kovács, M.D.
Isadore Levin, M.D.
Albert A. Martucci, M.D.
Robert L. Stecher, M.D.

Membership

Richard Kovács, M.D., *Chairman.*
John S. Hibben, M.D.
Emil J. C. Hildenbrand, M.D.
*O. Leonard Huddleston, M.D.

Military Problems

*Major O. L. Huddleston, (MC), *Chairman.*
*Lt. Comm. Edward Lee Alexander, (MC), U. S. N. R.
*Major Ben Boynton, (MC).
*Lt. Comm. Rodney Chamberlain, (MC), U. S. N. R.
*Lt. Comm. R. E. Kinneman, (MC), U. S. N. R.
*Major Donald Rose, (MC).
*Lt. Col. Norman E. Titus, (MC).
*Lt. Comm. John F. Wyman, (MC), U. S. N. R.

Nominating

Fred B. Moor, M.D., *Chairman.*
William Bierman, M.D.
Frank H. Krusen, M.D.
Nathan H. Polmer, M.D.
William H. Schmidt, M.D.

Problems Affecting Technicians

*O. Leonard Huddleston, M.D., *Chairman.*
Nathan H. Polmer, M.D.
Arthur L. Watkins, M.D.

Public Relations

William H. Schmidt, M.D., *Chairman.*
*H. Worley Kendell, M.D.
William B. Snow, M.D.

Scientific Exhibits and Gold Key Awards

*O. Leonard Huddleston, M.D., *Chairman.*
Robert L. Bennett, M.D.
John S. Coulter, M.D.
Disraeli Kobak, M.D.
Walter S. McClellan, M.D.

* In active service.

Center for Physical Therapy Established at Graduate School of Medicine of the University of Pennsylvania

The establishment of the first center for the scientific study and development of physical medicine as a branch of medical practice was announced by Basil O'Connor, President of The National Foundation for Infantile Paralysis. The center will be in the Graduate School of Medicine of the University of Pennsylvania at Philadelphia.

To set up this center, Mr. O'Connor stated, The National Foundation for Infantile Paralysis has made a grant totaling $150,000 for a five-year period from January 1, 1944 to December 31, 1948.

Mr. O'Connor said, "We believe this to be one of the most important steps which the National Foundation has taken. This will not only advance the treatment of infantile paralysis, but of many other diseases as well."

Mr. O'Connor explained that today there are only a few schools of departments connected with any of the medical training centers which are equipped to explore thoroughly on a sound scientific basis the possibilities of physical medicine.

This is but the first step in a program which, Mr. O'Connor said, should afford a scientific basis for physical therapy and lead to the establishment of a more desirable teaching program.

"If this branch of medicine can be given a sound professional standing," Mr. O'Connor declared, "medical men of the highest calibre will be attracted to it and practitioners will fully utilize its advantages. If research and study show there is little or no basis for treatment by some of the physical agents, then an equally great service will have been rendered, even though it be principally negative in character.

"Physical medicine plays a most important part in the treatment of infantile paralysis. Since it was first organized, the National Foundation has been continuously concerned with this phase of treatment. It has spent during the past six years over $350,000 to educate and train physical therapy technicians. An additional $364,000 has been granted to laboratories and universities to study many problems in physiology and medicine having a close connection with the practice of physical therapy, but never before has it been possible to combine in one place both medical research and teaching in this important field."

The Center for Research and Instruction in Physical Medicine will include:

1. A center for development of physical medicine as a scientific part of the practice of medicine.

2. A training center for medical leaders and teachers in this branch of medicine, and

3. A school for training technical workers under the guidance of such professional and scientific leadership, such a school to be only incidental to and dependent upon the first two purposes.

The Departments of Anatomy, Physiology, Pathology and other basic sciences of the University of Pennsylvania will cooperate in this proposed program. The general direction will be assigned to Dr. Robin C. Buerki, Dean of the Graduate School of Medicine.

Congress Members on Program of Meeting of the Society of Medical Jurisprudence

On December 13, The Society of Medical Jurisprudence held its 597th regular meeting at the New York Academy of Medicine Building, New York, N. Y. The speaker of the evening was Dr. Richard Kovacs who gave an illustrated paper, "Rehabilitation of the War Injured." The paper was discussed by Drs. Frank H. Krusen, George G. Deaver and Charles R. Brooke.

The Vocational Rehabilitation Program of The Veterans Administration

The following is quoted in part from Time magazine:

Ready for approval by Veterans Administration's Vocational Rehabilitation Service are applications from more than 1,000 ex-soldiers and sailors no longer able to fight, no longer able to earn respectable livings at odd jobs. Under a program quietly authorized by Congress last March, these men (and hundreds of thousands to follow) will be taught new trades, paid pensions ($100 a month for a married man with two children) while learning. Eventually they will be eased back into civilian life in new jobs.

Veterans Administration will do no training itself but will contract with factories — like Ford, General Motors — public and private schools and individuals. A veteran may be taught anything from typing to tatooing. In rare cases Veterans Administration may finance law or medical schooling.

Until the program gathers speed (and veterans) it will be financed from Veterans Administration's general funds — $600,000,000 for fiscal 1943. Judging by World War I's aftermath, when training for 180,000 men (a third of them dropped

out) cost $645,000, the program may eventually cost $1,500,000,000, handle 400,000 men. It must wind up six years after war's end. Said Administrator Frank T. Hines: "If we don't make a success of it this time we ought to be ashamed of ourselves."

Period of Apprenticeship in Army Hospitals.

The following is part of an official communication from the Office of the Surgeon General:

The purpose of the six months period of apprenticeship in Army hospitals is to offer to students the opportunity to receive practical experience in the actual treatment of patients in military hospitals and to become thoroughly indoctrinated in military customs and military procedures. Inasmuch as enlisted members of the Women's Army Corps being trained in Physical Therapy by the Medical Department of the Army have already had their basic military training, they are thoroughly versed in basic military subjects. It is believed that three months is sufficient for the required practical experience in Physical Therapy.

This office has had many communications indicating that the most difficult part of the Apprentice training is the adjustment to military service. A reduction in the six months period of apprenticeship for civilian Apprentice Physical Therapy Aides is not recommended at this time.

Dr. Clark Chief Medical Officer of the Office of Vocational Rehabilitation to Take Charge of Physical Rehabilitation Sectoin

Federal Security Administrator Paul V. McNutt has announced the assignment of Dr. Dean A. Clark, surgeon, U. S. Public Health Service, as chief medical officer of the Office of Vocational Rehabilitation to take charge of the newly established Physical Rehabilitation Section. The arrangement between these two branches of the Federal Security Agency was made by Surgeon General Thomas Parran at the request of Michael J. Shortley, director of vocational rehabilitation.

In commenting upon Dr. Clark's appointment, Mr. Shortley said that use of Federal funds for remedial medical treatment of the physically handicapped was authorized for the first time under the Barden-LaFollette Act of July 6, 1943.

"Until the expansion of the Vocational Rehabilitation progress under this new law," he said, "there was no Federal program for this purpose, although the Federal Government has long aided the States in providing vocational guidance and training for the handicapped. The addition of physical rehabilitation greatly strengthens the program, because relatively simple surgery often can materially decrease a physical handicap or even remove or fully compensate for it."

He explained that the new vocational rehabilitation program will make an important contribution to the war effort by facilitating the employment of the physically handicapped and thus promoting effective use of manpower for war work.

Mr. Shortley called attention to the fact that the rehabilitation program is designed to assist all physically handicapped individuals to obtain remunerative employment, except veterans with service-connected disabilities, who come under the program directed by the Veterans Administration. The program is operated by the States through their Boards of Vocational Education and their official agencies for the blind.

As a war measure, the Federal Government pays the full cost of rehabilitating war-disabled civilians. These include officers and crew members incapacitated while on war duty in the merchant marine, and members of the Aircraft Warning Service, Civil Air Patrol, and U. S. Citizens Defense Corps. For other individuals, the Federal Government pays half the cost of rehabilitation. All administrative expenses of the States in conducting approved rehabilitation programs are also met with Federal funds. Under the new statute, Federal aid may be utilized to provide all types of medical and surgical services necessary to modify a physical condition which is static and which constitutes a substantial handicap to employment. Conditions for which medical services are undertaken must, however, be of such a nature that treatment may be expected to eliminate or substantially reduce them within a reasonable length of time. Hospitalization not to exceed ninety days may also be furnished as well as prosthetic appliances essential for obtaining or retaining employment.

With Dr. Clark as chief medical officer, Mr. Shortley said, the Physical Rehabilitation Program will be directed by a physician with both a broad training in several fields of medicine closely associated with rehabilitation work and also experience in public administration. Since 1938, Dr. Clark has been engaged in work connected with the organization and distribution of medical care. On the staff of the U. S. Public Health Service since 1939, he was assigned to the Division of Public Health Methods, National Institute of Health, until 1942; for the last year and a half he has served as chief of the Emergency Medical Section of the Public Health Service and as chief of the Hospital Section, Medical Division, Office of Civilian Defense. A native of Minnesota and a graduate of Princeton University, Dr. Clark's background includes three years as a Rhodes Scholar at Oxford University, England, where he received the degrees of bachelor of arts and bachelor of science in physiology. In 1932, he took his medical degree at the Johns Hopkins Medical School, Baltimore, Md. He served an internship in medicine at the Johns Hopkins Hospital; later he was assistant resident in medicine and neurology at the New York Hospital, New York, N. Y.; National Research Council fellow in neurophysiology at the Cornell University Medical College, New York City; assistant resident at the Henry Phipps Psychiastric Clinic, Johns Hopkins, and interne at Trudeau Sanatorium, Trudeau, N. Y.

Postgraduate Course in Physical Therapy

The expectation that physical therapy would probably be much used for the treatment of injured ex-members of the armed forces of the present war in the hospitals of the Veterans Administration led to the effectuation in June of arrangements whereby physicians assigned to various field stations of the Veterans Administration were detailed for special courses in physical therapy at three of the leading clinics of the country. For a period of twelve weeks, 12 physicians were assigned to the section on physical therapy, Mayo Clinic, under the direction of Dr. Frank H. Krusen, 5 physicians to Northwestern University Medical School, Chicago, for instruction under Dr. John S. Coulter, member of the Medical Council, Veterans Administration and 4 physicians to Cornell University Medical School, New York City for instruction under Dr. Kristian G. Hansson.

Postgraduate Course in Electric Shock Therapy

For a ten day course of training in electric shock therapy 7 medical officers of the Veterans Administration were detailed to Bryce Hospital, Tuscaloosa, Ala.; Colorado School of Medicine, Denver, Colo.; Longview Hospital, Cincinnati, O.; Springfield State Hospital, Sykesvilles, Md.; State Psychopathic Hospital at Galveston, Tex.; Northport, Long Island, N. Y.

Occupational Therapy

Beatrice D. Wade, O.T.R., has recently been appointed associate professor and director of occupational therapy at the University of Illinois College of Medicine.

The Foster General Hospital

The Foster General Hospital, which was formally dedicated on September 18, is located in Jackson, Miss. The hospital is modern in every respect and is furnished with the finest construction with a total bed capacity of 1,768.

The Foster General Hospital was named for the late Col. Charles L. Foster, Mississippi army physician for many years.

Col. Sam F. Parker is commanding officer of the Foster General Hospital.

Major General Magee Becomes Executive Officer of Informational Service

Prof. Ross G. Harrison, Chairman of the National Research Council, has announced the appointment of Major Gen. James Carre Magee, Medical Corps, United States Army, retired, as executive officer of the Informational Service of the Council's Division of Medical Sciences. This service has been established by the National Research Council under the recent grant of the Johnson and Johnson Research Foundation, by which the sum of $75,000 was made available to the council for the period ending June 30, 1945. The purpose of the grant was to enable the council to assemble and disseminate, as far as possible, medical information pertaining to the war effort.

General Magee has had a distinguished record in the Medical Corps of the Army. A graduate of Jefferson Medical College in 1905, he has spent his entire professional life in the medical service of the Army. He was assigned to the Philippines before the outbreak of the first world war and then recalled for European duty from 1917 to 1919. He was appointed Surgeon General of the Army in 1939, and on May 31, 1943 he was retired on completion of the four year term of duty. It was under his direction that the Medical Corps was enormously expanded to meet the demands of the present war and the program of service adopted which has led to the remarkable health record of the Army. General Magee holds the honorary degree of doctor of science from Jefferson Medical College and was recently awarded the Distinguished Service Medal for outstanding accomplishments as Surgeon General.

General Magee, on assuming his duties, will devote full time to the organization of a central office in the National Research Council which will collect medical reports and records widely dealing with military medical practice, civilian practice as affected by the war, medical education and research and the distribution of diseases. The materials collected will, so far as military necessities permit, be made available by publications, summaries and notes.

Public Health Service Reorganized

Thomas Parran, surgeon general of the U. S. Public Health Service has announced the names of five persons to head the new bureaus and divisions set up through the reorganization of the U. S. Public Health Service by Congress November 11. The reorganization was authorized in the enactment of a bill (S. 400). Dr. Lewis R. Thompson, medical director serving in the surgeon general's office, has been named assistant surgeon in charge of the new Bureau of States Services. Dr. Ralph C. Williams, formerly district director, has been named assistant surgeon general in charge of the new Bureau of Medical Services. Dr. Rolla E. Dyer, director of the National Institute of Health, Bethesda, Md., will in addition serve as assistant surgeon general in charge of the new Bureau of Scientific Research. John R. Hoskins, senior sanitary engineer, under the new setup will become chief of the division of sanitary engineering and William T. Wright, Jr., D.D.S., chief of dental work in the Marine Hospital Division of the public health service, will become chief of the division of dentistry. All five will hold ranks comparable to an army brigadier general, it was announced.

Twenty-Five Years as Head of Department of Physiology

On November 18 associates and students of Dr. Carl J. Wiggers gave a dinner to honor him on his completion of twenty-five years as professor and head of the department of physiology at Western

Reserve University School of Medicine, Cleveland. Dr. Torald Sollmann, dean of the medical school, presided. Dr. Wiggers, who graduated at the University of Michigan Medical School, Ann Arbor, in 1906, joined the physiology department at Western Reserve in 1913, serving as assistant professor of physiology.

Course in Hospital Administration at Northwestern

The Johnson and Johnson Research Foundation, New Brunswick, N. J., recently made a grant to Northwestern University Medical School to assist in making possible a special course in hospital administration. Students enrolled in the course represent nineteen different hospitals. Of eight students not connected with a hospital, two are employed on hospital magazines, two are physicians, one is director of a hospital council and one is employed by the American College of Surgeons.

Emergency Surgery of the Extremities

Circular Letter No. 189 of the Office of the Surgeon General is concerned with emergency surgery of the extremities. It was issued on November 17 to all medical officers of the United States Army.

Harvard Medical School

Dr. Charles Walter Clarke, executive director of the American Social Hygiene Association, New York, has been appointed clinical professor of public health practice at Harvard University. Dr. Harry C. Solomon, clinical professor of psychiatry, has been appointed professor of psychiatry at Harvard Medical School and medical director of the Boston Psychopathic Hospital, suceeding the late Dr. C. Macfie Campbell.

Opportunity for Crippled Children

The annual sale of Easter seals this war year of 1944 comes as a reminder of the problem of the crippled youth of America—a problem which is underlined by the nature of the times. The Easter seal has come to symbolize the complete and ideal program for the adjustment and restoration of handicapped children to a normal and happy life. This program, which requires many agencies, both public and private, to effect, consists of five main points. These are an opportunity for the child to get well, to go to school, to play with other children, to learn a trade or profession, and to work for a living. In short, they constitute the same list of opportunities America asks for all of her children. The growth of the annual Easter seal sale, sponsored by the National Society for Crippled Children, reflects the public desire that this work continue and flourish. This year as never before we should support the work of the voluntary service organization. The sale of Easter seals offers an opportunity for all citizens to share in the important job of building crippled children into happy and useful men and women.

University of Minnesota Medical School

The eleventh E. Starr Judd lecture was delivered in the Museum of Natural History Auditorium at the University of Minnesota, December 6, by Major Gen. Norman T. Kirk, Surgeon General of the U. S. Army. His subject was, "Surgery in War."

Dr. Ernst Gellhorn, professor of physiology, University of Illinois College of Medicine, has been appointed professor of physiology and head of a special unit in neurophysiology for the study of infantile paralysis that the National Foundation for Infantile Paralysis is sponsoring for Minnesota.

University of Cincinnati College of Medicine

A public campaign to raise at least $300,000, to be donated to the college as a fund dedicated to the memory of Dr. Mont R. Reid, late professor of surgery, was launched recently under the auspices of a local committee. The fund is to be used to supplement the regular budget of the college and is intended to "honor the memory of a great citizen, to advance the cause of medical science and teaching and to promote the health of our community."

Wayne University College of Medicine

The first full-time appointment of a Negro to the faculty of Wayne was confirmed by the Board of Education when Dr. C. W. Buggs of Dillard University, New Orleans, was made instructor in bacteriology.

University of Utah School of Medicine

Dr. Maxwell Myer Wintrobe, formerly associate professor at the Johns Hopkins University School of Medicine, Baltimore, has been appointed professor and head of the department of internal medicine.

University of North Carolina School of Medicine

Dr. John H. Ferguson, of the department of pharmacology of the University of Michigan Medical School, has been appointed professor and head of the department of physiology.

Superintendent Named for Occupational Therapy

Mrs. Winifred C. Kahmann, director of occupational therapy and physical therapy at the Indiana University Medical Center, Indianapolis-Bloomington, has been appointed superintendent of the new occupational therapy program of the Surgeon General's Office of the Army. She was granted a leave of absence by the university to start her new activities in Washington, November 17. Mrs. Kahmann will work as an assistant to Major Walter E. Barton, M. C., A. U. S., formerly engaged in neuropsychiatric work in the Army, who has been placed in charge of the reconditioning division in the Surgeon General's Office.

Association of American Medical Colleges Meets in Cleveland

The fifty-fourth annual meeting of the Association of American Medical Colleges was held in Cleveland, October 25-27, 1943. The attendance was better than ever before, only three member colleges not being represented by one or more delegates: Temple University School of Medicine, University of Manitoba Faculty of Medicine and the College of Medicine of the University of the Philippines. The total number of delegates from member colleges was 176.

Lewellys F. Barker

Dr. Lewellys F. Barker, emeritus professor of medicine at the Johns Hopkins University School of Medicine since 1913, former professor of anatomy at the University of Chicago, and chairman of the Medical Council, Veterans Administration, died July 13 at his home in Baltimore, at the age of 75, after a lingering illness.

William E. Lawson

It is with regret that we announce the passing of one of the Life Members of the Congress, Dr. William E. Lawson of Homestead, Penna.

CORRESPONDENCE

Re: "Physiomedy" *vs.* Physical Medicine

To the Editor: The following names are offered for consideration in regards to our specialty:

1. For the Specialist in Physical Medicine—Physiomedist. (Accent on the O.)
2. For the Specialty of Physical Medicine—Physiomedy. (Accent on the O.)
3. For the adjective descriptive of the Specialty (Accent on the E)—Physiomedic or Physiomedical.

The technician would thus be a Physiomedic Technician or Physiomedic Aide.

The modalities would be Physiomedic Modalities.

Treatments would be Physiomedic Treatments.

Diagnostic Procedures would be Physiomedic Diagnostic Procedures.

Preventive Measures would be Physiomedic Preventive Measures.

Apparatus would be Physiomedic Apparatus.

The Council on Physical Therapy would be the Council on Physiomedy.

The Board of Physical Medicine would be the Board of Physiomedy.

The Archives of Physical Therapy would become the Archives of Physiomedy.

HARRY T. ZANKEL,
Captain, Medical Corps,
Chief, Physical Therapy Section, Borden General Hospital, Chickasha, Okla.

The Human Foot — Bettmann

(*Continued from page 26*)

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21. Mayer, Leo, and Bisalsky, Konrad: Die Physiologischen Sehnen Transplantationen, Berlin, Springer, 1916.
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BOOK REVIEWS

OFFICE TREATMENT OF THE NOSE, THROAT AND EAR. By *Abraham R. Hollender*, M. Sc., M.D., F.A.C.S., Associate Professor of Laryngology, Rhinology and Otology, University of Illinois College of Medicine; Otolaryngologist, Research and Educational Hospitals, Chicago, Illinois. Cloth. Pp. 480, illustrated. Price, $5.00. Chicago: The Year Book Publishers, Inc., 1943.

Few books on this subject stress the office management of otolaryngologic diseases. This is apparently the first monograph on the office treatment of the nose, throat and ear.

The otolaryngologists are constantly widening the scope of office practice. This book explains in detail and clearly the "when" and the "how" of various scientific office procedures, and indicates when such measures should be discontinued in order to afford patients the benefit of indicated hospital care.

The book is divided into seven parts. The first part gives a general survey of office therapeutic measures. In one chapter of this part physical therapeutic procedures are evaluated. The author considers infra-red radiation, diathermy, ultraviolet radiation and ion transfer. The other parts consider diseases of the nose, paranasal sinuses, mouth and pharynx, larynx, ear and nervous disorders. The illustrations are excellent. This monograph is highly recommended to medical students and practitioners because it reveals a large field of treatment outside of the hospital wards and the operating room.

THE PHYSIOLOGICAL BASIS OF MEDICAL PRACTICE: A University of Toronto Text in Applied Physiology. By *Charles Herbert Best*, M.A., M.D., D. Sc., Professor and Head of Department of Physiology, University of Toronto, and *Norman Burke Taylor*, M.D., F.R.S., F.R.C.S., Professor of Physiology, University of Toronto. Third edition. Cloth. Price, $10.00. Pp. 1942, with 497 illustrations. Baltimore: The Williams and Wilkins Company, 1943.

This is the third edition of a standard, voluminous work on physiology. The authors state in the preface that it had been their original intention to delay the revision until after the war. However, in view of the fact that there was a great need for bringing the present information on physiology up to date, it was decided to reedit the book sooner than expected, in order that the fullest scope of physiology possible might be presented to the students of medicine during this period of emergency.

The general plan of presentation of the book remains unchanged and no new chapters have been added. However, the book is about fifty pages longer than the previous editions.

Important new knowledge of the experimental and therapeutic functions of vitamin K and discoumarin is included. In the section on the Rh factor, important information on clinical transfusion has been added. This no doubt will be of wide interest to students of military medicine especially. The sections dealing with the constantly changing subjects of shock and the control of blood volume have also been revised. New material has been added to the section on blood velocity and coagulation of blood. The discussion of dyspnea, anoxia and the control of respiration has been revised extensively. Important developments in the study of pathologic physiology of renal diseases are cited. Less significant alterations and revisions occur in the chapter on gastric and intestinal digestion. New information on the chemistry of destruction of glycogen, especially as it is affected by muscular exertion, is presented. There are also reports of recent studies on the effect of blood sugar levels on the role of glycogenesis. The section on metabolism of phospholipids has been brought up to date. It is impossible in a review of a book of this size to give a complete list of the changes that have been made.

The book might be criticized in that it is too voluminous on certain subjects and too brief on other subjects. However, it remains an outstanding textbook in physiology, both for the medical student and as a reference book. There is an extensive bibliography and the book is well written and edited. The fact that this huge book has been published and revised so frequently indicates the untiring efforts of the authors to keep the contents of this volume up to date. It is one of the finest books on the subject.

AN ATLAS OF ANATOMY. By *J. C. Boileau Grant*, Professor of Anatomy in the University of Toronto. 2 Volumes. Cloth. Pp. 214. Illustrated. Vol. I. Price, $5.00. Baltimore: The Williams and Wilkins Co., 1943.

This is an outstanding atlas of anatomy which takes anatomy from the dead body to the living. The first volume describes and illustrates the upper limb, abdomen, perineum, pelvis and the lower limb. The second volume to be published later covers the thorax, head and neck, vertebral column and back.

The prominent and attractive feature of this atlas is the accuracy and the number of color plates. The accuracy of the plates is established by photographic means. The drawings are by Mrs. Dorothy I. Chubb, a pupil of the late Max Broedel. Many of the color plates are in three or four colors and show the collaboration of the artist and anatomist. Every plate is a work of art. Clear labeling leaves no doubt as to what is shown. The index leads quickly to the plates in which any structure is shown. This volume can be highly recommended.

VASCULAR SPASM. EXPERIMENTAL STUDIES. By *Alexander John Nedzel,* M.D., M.S., Associate Professor of Pathology, University of Illinois College of Medicine. Cloth. Price, $2.75. Paper. Pp. 151 with 161 figures. Urbana, Illinois: The University of Illinois Press, 1943.

The present monograph constitutes Numbers 2 and 3 of Volume III of Illinois Medical and Dental Monographs. The author defines "vascular spasm" as an "exaggerated state of hypertone . . . limited to a certain region, organ, or part of the body, or even to one artery." The volume is made up of descriptions of experimental studies and literature reviews dealing with the production and results of vascular spasm as already defined.

A section on splancho-peripheral balance deals with the effects of heat and cold, applied to the skin surface, on the functions of abdominal and thoracic viscera. Since organ temperature is a function of activity, temperature determinations of these organs were made by means of thermocouples. The viscera studied were the gastrointestinal tract, the liver, the kidneys and the respiratory tract. It was shown that definite changes in the temperature of these organs could be produced by the application of heat or cold to the adjacent overlying skin. These effects were shown to be reflex in nature. With changing environmental temperature there is a shift of blood from the splanchnic area to the periphery and vice versa.

As an agent to produce vascular spasm experimentally in animals the author chose pitressin, although in some experiments epinephrine was also used. In a study of the influence of sudden increases in blood pressure on the heart valves, it was shown that the rise in tension causes damage to the valve margins so that they become gelatinous and sticky and encourage bacteria to lodge on them. Pressure episodes, associated with infections such as those of the respiratory tract, furnish the elements necessary for the initiation of endocarditis.

By the repeated intravenous injection of pitressin in dogs the author was able to produce gastric ulcers in 38 per cent of the experimental animals. This coincides with the well known relation of peptic ulcer to emotional stress. Large doses of pitressin injected intravenously in dogs gave rise to pathologic changes in the liver and kidneys associated with vascular abnormalities, dilated vessels and local hemorrhages, followed by cell destruction, extensive fatty degeneration in the liver and fat droplets in the kidney with hyaline casts.

From a survey of the literature, the author came to the conclusion that the lesions of multiple sclerosis are caused by vascular damage with resulting patchy destruction of nervous tissue and subsequent scarring. The agent producing the vascular changes is not known. In animals the author by means of pitressin was able to produce lesions in the central nervous system resembling those seen in the human.

The volume is concluded by a bibliography of fourteen pages. This is an interesting and valuable monograph on the experimental results of vascular spasm together with their clinical implications in relation to endocarditis, gastric ulcer, multiple sclerosis and certain lesions of the liver and kidneys. It should be read by those interested in the pathology of these organs and the diseases concerned. The chapter on splancho-peripheral balance is of importance in the field of physical therapy.

AN INTRODUCTION TO BIOPHYSICS. By *Otto Stuhlman,* Jr., Ph.D., Professor Physics, University of North Carolina. Cloth. Pp. 375 with 154 illustrations. Price, $4.00. New York: John Wiley and Sons, Inc., 1943.

The growing realization on the part of all scientists of the close relation existing between the so-called biologic and physical sciences is a fact of great encouragement to physicians who have taught and practiced physical therapy. There is probably no physical or chemical law of engineering principle that cannot be illustrated by an example taken from the living body. It is indeed gratifying therefore that books of the type represented by that of Stuhlman on biophysics are becoming available to students of medicine and biology. This work is an introduction to the subject and is not intended to be a comprehensive treatise. It covers biophysically active x-radiation, applied radioactivity, the biophysical characteristics of the eye, the emission and absorption of biophysically active light, the structure and properties of surfaces and membranes, the biophysical problem of nerve conduction, auditory biophysics and the theory and application of the compound and the electron microscope.

The book was written as a text for students whose primary interests lie in the biologic sciences with the view that it would lead to a fuller appreciation and understanding of the applications of physics to biologic problems. It should be suitable as a text book for mature students who have the necessary scientific background, a year's work in enough mathematics followed by one year's study of the fundamental principles of physics and chemistry. A selection of problems with answers is provided, a feature that will appeal to those who may wish to use the book as a reference and text for independent study.

ESSENTIALS OF INDUSTRIAL HEALTH. By *C. O. Sappington,* M.D., Dr. P.H. Cloth. Pp. 626, 63 illustrations. Price, $6.50. Philadelphia: J. B. Lippincott Company, 1943.

This book should serve as an excellent reference source for physicians called on to deal with problems of industrial health management and as a standard text for students in this field. The subject is dealt with in three parts: first, industrial health administration, which describes the history of its development, statistics on occupational hazards, types of health services to be considered and recommendations for proper industrial medical care; second, industrial hygiene and toxicology, dealing with the various health exposures in summary and tabular form, and providing in more detail specific measures to be taken for protection including plant surveys,

sanitation and personal hygiene. In the third part some of the common problems of industrial medicine and traumatic surgery are elaborated on. Evidence is presented of the importance of examination of the worker's physical and mental fitness for jobs of different types and hazards. Data on the prevalence of accidents and diseases is included and the proper medical management outlined with suggestions for prevention. The importance of rehabilitation is emphasized including the value of adequate physical therapy although detailed information is lacking as to methods to be employed.

The work is well edited with an abundance of clear, easily readable graphs, tables, charts and diagrams as well as illustrations. It is heartily recommended for all physicians interested in industrial medicine.

STUTTERING — SIGNIFICANT THEORIES AND THERAPIES. By *Eugene F. Hahn*. Assistant Professor in Speech Education and Director of the Speech Clinic, Wayne University, Detroit. Cloth. Pp. 177. Price, $2.00. Stanford University, California. Stanford University Press, 1943.

This symposium on stuttering consists of a collection of twenty-five separate summaries of the theories concerning etiology and modes of treatment adopted by leading authorities in this field in America and Europe. The diversity of opinion is somewhat overwhelming as theories of etiology range from those of the psychoanalytic school to others emphasizing the structural neurologic alterations. One can conclude that there is no single etiologic factor to be dealt with and the therapies recommended include methods aimed at correcting abnormalities of emotional control as well as of the motor mechanisms of speech. In the appendix the author clarifies some of the discrepancies of opinion and illustrates the value of multiple methods of treatment. Although a detailed description of speech correction is not included, this volume should serve as a valuable reference or text for students and clinicians in this important field.

BRUCELLOSIS IN MAN AND ANIMALS. By *I. Forest Huddleson*, D.V.M., Ph.D., Research Professor in Bacteriology, Michigan State College. Contributing authors: *A. V. Hardy*, M.S., M.D., Dr. P.H., Associate Professor Epidemiology, DeLamar Institute of Public Health, Columbia University Medical School, Consultant, U. S. Public Health Service; *J. E. Debono*, M.D., M.R.C.P., Professor of Pharmacology and Therapeutics, Royal University of Malta; *Ward Giltner*, D.V.M., M.S., Dr. P. H., Dean of Veterinary Division and Professor of Bacteriology, Michigan State College. Revised edition. Cloth. Pp. 379 with 42 illustrations. Price, $3.50. New York: The Commonwealth Fund, 1943.

This is a revised edition of a monograph on a disease which, although considered relatively uncommon, is becoming much more widely known and is diagnosed much more frequently at present than it was a few years ago. Undoubtedly, the author in his previous two books and voluminous writing has done much to create an interest in a disease which is more prevalent than previously thought. The disease is known to be common in animals, especially in cattle and hogs, from which man obtains his food. The author has spent a great deal of time in the study of this disease and, as is pointed out in the preface to the first edition of his book, he has been more or less the classical writer on brucellosis during this century.

The book covers the subject rather exhaustively. Section I includes a discussion of the classification of the bacteria and their various characteristics. Section II deals with the methods of isolation of the organism. Section III discusses the differentiation of the species of the genus Brucella, which includes the agglutinin absorption test applied to unknown cultures, the preparation of type-specific serums and the like.

Section IV is a discussion of brucellosis in human beings. This includes the epidemiology, pathology, clinical analysis, localization of the brucella infections, diagnosis, differential diagnosis, differential diagnosis and prognosis. In this section, there is a discussion by the co-author J. E. Debono on brucellosis in Malta. In the same section, there is also a long discussion of the specific and chemical methods of treatment—treatment by brucellin, methods of preparing the brucellin, potency tests, directions for using brucellin, contraindications and analysis of cases in which brucellin was used in treatment.

Section V is on brucellosis in animals. This likewise is divided into parts with chapters on the history, pathology and the like, of brucellosis in cattle, hogs and goats. There is some discussion of the Brucella as it occurs in other animals.

Section VI deals with the laboratory diagnosis of brucellosis including serologic methods, agglutination test for human beings and for cattle, giving a description of the apparatus necessary in the preparation of antigen, titrating antigen for sensitivity, testing of blood serum and milk and the interpretation of results of tests. There is also a discussion of the allergic and opsonocytophagic tests at some length. The last section, VII, deals with the eradication and control of the sources of brucellosis infection and was written by Ward Giltner, another co-author.

In the appendix, there is a presentation of the large number of cases in these reports to illustrate the various clinical types of brucellosis such as the intermittent, the ambulatory, the undulant and the malignant types.

The book is well outlined and the subject is well presented. There is an exhaustive bibliography on the subject in which some 485 references are cited. The author has done a splendid piece of work, giving an exhaustive survey of this subject. Not only has he presented a vast amount of material which undoubtedly he has gleaned from his own experience, but he also has made a wide survey of the disease over this country and in some parts of Europe. There is a sufficient evidence presented concerning the

several types of treatment to clarify the subject to a certain extent as to what constitutes the best treatment of the disease. However, there may be disagreement with the author on his statement that "There were at one time many who advocated artificial fever therapy in the treatment of brucellosis, but like many other treatments it no longer has much support." At several medical centers fever therapy is available, it is considered an important method of treatment of this disease. There are now a sufficient number of cases of brucellosis being collected to indicate that possibly fever therapy may constitute one of the best treatments of brucellosis.

The book can be recommended highly to the health authorities and to others particularly interested in the treatment of this disease. It is an excellent reference book on the subject.

CLINICAL SIGNIFICANCE TO THE BLOOD IN TUBERCULOSIS. By *Gulli Lindh Muller*, M.D., Pathologist and Director of Laboratory, New England Hospital for Women and Children, Boston; formerly Pathologist, Rutland State Sanatorium, Rutland, Massachusetts. Cloth. Pp. 516 with 52 tables and 19 charts. Price, $3.50. New York: The Commonwealth Fund, 1943.

The purpose of this volume is to satisfy a need for a better comprehension of the hematologic findings in tuberculosis, using modern methods and interpretations. The material in the book is based on 1,000 consecutive cases in which 6,819 complete blood studies were made. Each blood examination was correlated with the clinical aspects of the case present at the time. Although this work deals chiefly with pulmonary tuberculosis, a few extrapulmonary cases were included but not separately analyzed.

The book is divided into six parts: (1) Physiology of the blood forming organs and cellular response to the tubercle bacillus; (2) changes in the circulating blood in tuberculosis; (3) the sedimentation rate; (4) clinical and hematological data as measures of constitutional reaction; (5) the effect of therapeutic methods, exercise, and certain complications on the hematological picture; (6) examination of the blood.

The response of the bone marrow to tuberculous infections is similar to that in acute infections, but less intense: namely, the appearance of younger myeloid cells. In addition to the generally accepted importance of monocytes and lymphocytes in tuberculous lesions, the author calls attention to the presence of neutrophils especially in fatal cases.

In the circulating blood the total white cell count is not characteristic but the percentage differential count is of value. With increasing severity of the disease and with rising temperatures, the percentage of neutrophils in the circulating blood increases, reaching to 80 per cent or over in almost 60 per cent of cases. The Arneth count is considered to be of both diagnostic and prognostic value in tuberculosis. The importance of monocytes and lymphocytes and the monocyte-lymphocyte ratio in the circulating blood is emphasized. There is no correlation of eosinophilia with the activity of the tuberculous lesion, but eosinopenia increases with increased activity as indicated by the temperature. An important chapter is devoted to leucocytic formulae, especially those of Richard and Medlar. In general, it may be said that neutrophilic leucocytosis with an increase in band forms is unfavorable while lymphocytosis is favorable in tuberculosis. Severe anemia with hemoglobin levels below 50 per cent is not commonly seen.

The discussion of the sedimentation rate deals with the history, the mechanism of blood sedimentation, factors which influence the rate, and methods of performing and correcting the sedimentation rate. This is an excellent discussion to which five chapters have been devoted.

A correlation coefficient was developed from the patient's clinical findings of weight, temperature, pulse, sputum, and complications and the hematologic data of sedimentation rate, neutrophilic band forms, and leucocytes. Direct correlation of clinical and hemotological data was found in only 40 per cent of cases.

The author has given careful consideration to the effect of such factors as artificial pneumothorax, thoracoplasty, and exercise on the hematologic picture. Such complications as pleurisy with effusion, empyema, spontaneous pneumothorax, and acute abdominal infections are also discussed. A brief final chapter has been devoted to methods and apparatus used in examination of the blood. There is an excellent bibliography of forty-five pages.

The reviewer's first impression of this volume was one of surprise that so much space should be devoted to the blood picture in one single disease. Although it could doubtless be considerably abbreviated, this would certainly detract from its value as an authoritative work on the subject under consideration. It is a worthwhile contribution in its field.

PHYSICAL THERAPY ABSTRACTS

March Fracture of the Metatarsal Bones. H. H. Fouracre Barns.

Brit. M. J. **4323**:609 (Nov. 13) 1943.

March fractures, or spontaneous stress fracture, is most often seen in the metatarsal bones, but has been observed in others, including the femur. This type of fracture was well recognized before and during World War I. A number of articles have been published recording cases that have appeared during the present conflict.

Present treatment has consisted of a below-knee plaster, with a walking-heel attached, for approximately four weeks. The toes have been left free on the dorsal aspect and the ankle has been immobilized at a right-angle. Following this the patient has had light duty for two weeks, avoiding all vigorous exercises. At the end of the six weeks he has resumed full duty with the exception of excessive exercise and long marching. No residual disability has been encountered.

It is suggested that the exciting force responsible for the fracture is supplied by the repeated muscular action of the plantar flexors of the toes and foot during the springy movement of walking. Suggestions for the reduction of the incidence of this type of fracture are offered.

Physical Therapy in Psychiatric Practice. Winfred Overholser.

J. A. M. A. **123**:32 (Sept. 4) 1943.

The interest of psychiatrists in physical therapy perhaps antedates that of any other medical specialty. As knowledge of the bodily factors in mental states has developed, the utilization of physical therapy in psychiatric practice has gained. In addition to the direct effect on various bodily organs and organ systems, however, an effect is exerted on the whole patient by anything which modifies his physical environment, whether this is within his body, on the surface of his body or in the world about him. It is these effects on the whole patient which are referred to as psychologic.

In psychiatric practice two general classifications of physical therapy may be made. One includes the types which are prescribed primarily on account of the total behavior of the patient, that is, on account of his mental condition; such are, for example, the continuous bath and the wet sheet pack for states involving tension, overactivity and restlessness, and the various forms of stimulative therapy, such as the contract douche, the salt glow, the friction rub and ultraviolet therapy, which may be utilized in states of depression and decreased motor activity. In the other group are included numerous other forms of physical therapy which are useful even though they are directed toward systemic conditions or the conditions of particular organs. The latter group of modalities likewise have a beneficial effect on the mental state of the patient, although this effect may be referred to as in some ways a by-product.

Of the forms of physical therapy prescribed for primarily psychiatric reasons, the form which is by far the most commonly used is the continuous neutral bath. Next in point of frequency to the continuous bath is found the wet sheet pack.

Under the general heading of stimulative hydrotherapy one finds a number of procedures, all more or less related and somewhat similar in principle, involving the application of cool water which is under more or less pressure and of various temperatures, accompanied or not by friction. The particular varieties depend in part on the physical condition of the patient and on his general cooperativeness. They are particularly useful in mental conditions characterized by a tendency to inactivity as, for example, in the depressions and those types of schizophrenia in which catatonic features are rather prominent. Some of them, in order to increase the contrast and reaction, may be preceded by a brief period under close observation in the electric bath cabinet or the vapor cabinet. In general, however, these particular forms of the application of heat are of doubtful value in psychiatric practice. Considerable hazard is involved in any event, and with a disturbed patient burns may be incurred.

The needle or circular type of douche is in common use. Saline baths are spoken of in the literature, but they are not used with any great generality.

An important form of physical therapy in mental hospitals is found in the use of the fever cabinet. Another form of physical therapy which is highly characteristic of mental hospitals and which indeed should not be employed outside of a hospital is the so-called electric shock therapy.

Some investigation of the effects of low temperature has been carried on in a few psychiatric centers but with dubious results.

Massage should be available for its local effects on disabled joints and muscles and for general relaxation as well.

Muscular Activity and Choline Esterase. Phyllis G. Croft, and D. Richter.

J. Physiol. **102**:168 (Sept. 30) 1943.

It was reported recently that the serum choline esterase activity is raised by muscular exercise in man. This observation suggested that the high choline esterase activities that have been found

clinically in thyrotoxicosis and in acute emotional states might be due to the increased neuromuscular activity commonly seen in these conditions.

The investigation has now been pursued with a view to defining more clearly the relation between the serum choline esterase and muscular activity. The source of the additional choline esterase which appears in the serum during muscular effort has also been investigated.

The serum choline esterase activity is raised during muscular exercise in man. The choline esterase of the blood corpuscles falls during muscular exercise and this may account for the rise in the serum choline esterase. Some of the aliesterase in the red blood corpuscles also passes into the serum during muscular exercise.

The serum choline esterase activity is not raised by the administration of adrenaline, ergotamine or histamine or by overbreathing, underbreathing or rebreathing the expired air. The serum choline esterase activity is raised during circulatory stasis, which is due to the increase in the concentration of the serum proteins; it is not related to the rise during muscular exercise.

Psychogenic Rheumatism. Edward W. Boland, and William P. Corr.

J. A. M. A. **123**:805 (Nov. 27) 1943.

The authors hold no brief for the concept that organic joint disease, such as chronic rheumatoid arthritis, may result from psychic conflicts. In view of the absence of sound supporting evidence, such a thesis seems entirely unwarranted. While being cognizant of the fact that a psychoneurotic state may be kindled by a chronic illness such as arthritis, the authors do not support the theory that mental factors are etiologically related to inflammatory joint disease. The authors' attempt to salvage these patients with psychogenic rheumatism and to return them to either full or limited duty have been largely unsuccessful. It is hoped that more prompt recognition and proper psychotherapy instead of physical therapy will prevent some of these psychogenic rheumatism casualties.

The Effect of Temperature on Blood Flow and Deep Temperature in the Human Forearm. B. H. Barcroft, and O. G. Edholm.

J. Physiol. **102**:19 (June 30) 1943.

The present paper describes the variations in blood flow as a result of changes in the temperature of the surrounding water.

The blood flow and deep muscle temperature have been measured in the human forearm for two hours after its immersion in water at temperatures ranging from 13 to 45-0 C. The average forearm blood flows range from 0-5 cc./100 cc. forearm/min. at 13-0 C. to 17-6 cc. at 45-0 C.

The flow time relations fall into three groups: (a) 13-35-0 C. Slight decrease in flow during the two hours; not conspicuous except in first fifteen minutes; (b) 37-42-5 C. The flow increases to a maximum in about one hour, then decreases steadily; (c) 45-0 C. Increases to a maximum in thirty to forty-five minutes, then remains constant.

The significance of these time relations is discussed. The higher the water temperature the more frequent are the spontaneous fluctuations in blood flow. The deep muscle temperature not far from the middle of the thickness of the upper part of the forearm ranged from 18-0 C. after two hours immersion at 13-0 C. to 39-0 C. after thirty minutes immersion at 42-5-45-0 C.

Fixed Eruption, Conjunctivitis and Fever From Sulfathiazole. William Director.

Arch. Dermat. & Syphil. **48**:523 (Nov.) 1943.

Cutaneous reactions from sulfonamide compounds are not infrequent, but conjunctivitis as a reaction is less common. In a recent paper, Dowling and Lepper reported among their total of 149 patients with various reactions from sulfonamide compounds 7 with dermatitis alone, 3 with conjunctivitis alone, 5 with fever alone, 1 with dermatitis and conjunctivitis, 6 with dermatitis and fever, 3 with conjunctivitis and fever and 2 with all three complications.

A report is given of a case of fixed dermatitis, conjunctivitis and fever. The term "fixed" is used in the sense that the dermatitis is confined on recurring attacks to the same sites. Dowling and Lepper did not mention whether or not in any of their cases the site was fixed.

The Effect of Exercise on Chloride Excretion in Man During Water Diuresis and During Tea Diuresis. M. Grace Eggleton.

J. Physiol. **102**:154 (Sept. 30) 1943.

In studies on the effect of exercise on urinary excretion in man, some diuretic is habitually used to facilitate frequent sampling of urine. An attempt has now been made to differentiate the changes in urinary excretion due to exercise and those due to the diuretic employed, by experiments under more comparable conditions.

A short period of severe exercise superimposed on a tea diuresis results, as in a water diuresis, in an increased excretion of phosphate, titratable acidity and ammonia and a fall in pH. A temporary decrease in output of creatinine, total nitrogen and chloride also occurs under both sets of conditions. The more permanent decrease in total nitrogen, chloride and water output following exercise during water diuresis is not observed during tea diuresis. A more accurate comparison of the effects of exercise on the output of water and chloride during the two types of diuresis, made on the same persons, gave the following results: (a) A large individual variation occurred in the duration of inhibition of water diuresis as the result of such exercise; (b) this variation was not haphazard; the same duration of inhibition was observed also under tea diuresis in the same person; (c) the total output of water also varied widely in different individuals. That following tea diuresis was always

greater and bore a fairly regular relation to that following water diuresis; (d) chloride execretion was greatly diminished for thirty-five minutes after the exercise in both types of diuresis. The subsequent rise was much greater in the tea diuresis but fell again as water output increased. The total chloride output in water-diuresis experiments was only 40 per cent of that in the tea-diuresis experiments.

Control-diuresis experiments without exercise showed: (a) A decrease in chloride output during water diuresis averaging 30 per cent. The course of this change was not closely related to the increase in output of water and in absolute magnitude varied roughly inversely with the degree of diuresis; (b) an increase in chloride output during tea diuresis averaging 50 per cent.

It is suggested that the inhibition of diuresis immediately following the exercise is due to vasoconstriction and nervous interference with the pituitary mechanism, and that the more variable and prolonged inhibition may be due to secretion of anti-diuretic hormone resulting from the concentration of blood resultant on the exercise.

Regeneration of Nerve.

Lancet **20**:611 (Nov. 13) 1943.

Knowledge of the rate of nerve regeneration is useful for determining the time at which recovery may be expected after nerve suture, and still more important in cases where nerves have been injured but not sutured. Absence of exact information about the time at which spontaneous recovery may be expected probably leads to undue delay before exploratory operation in many of these cases. The rate which is required is, of course, not that of the advance of the tips of the new fibres. Thin nerve-fibers may reach a muscle long before it shows recovery. Before the new stretch of nerve can function the nerve-fibers must thicken and medullate. By studying the time at which function returns in muscles at various distances from the lesion we can therefore estimate the rate of advance of what may be called functional completion along the nerve. Seddon, Medawar and Smith have made a careful study in this way of the rate of recovery in 25 cases, mostly in the radial nerve. The distance from the lesion (or suture) to the various muscles was estimated from a series of dissections. Recovery was found to take place in a regular serial manner, but plots of the distance of each muscle from the lesion against the time of recovery often do not give straight lines, suggesting that regeneration is fast at first and becomes slower for the more distal muscles. There is, therefore, no constant "rate of regeneration." The data are not sufficient to allow the shape of the curve describing the decline to be discovered accurately, but Seddon and his colleagues suggest that it may be a hyperbola, the rate being inversely proportional to the square of the time, beginning as high as 3 mm. a day, and falling to about 1 mm. a day at 100 days or so after recovery has started. This would agree with the findings of Gutmann and others that regeneration to the level of functional completion may proceed down the short nerves of rabbits as fast as 3 to 5 mm. a day. Until more is known of the course of decline in the rate of recovery average values can be used for comparing the results after different types of lesion. The rate per day in the radial nerve after suture was found to be 1 to 6 mm. as the average of 6 cases, with variations between 1 to 0 and 2 to 4 mm. In 10 patients with "spontaneous" recovery (axonotmesis) the average rate was 1 to 5 and the limits 0 to 7 and 2 to 1 mm. per day. The rate of recovery in 14 cases of suture of radial nerve described by Stopford can be calculated in the same way and proves to be only 0 to 6 with extremes of 0 to 4 and 0 to 7 mm. per day. The reason for the strikingly faster rate in the recent cases remains obscure. The possibility of making such comparisons shows the value of the method. It is to be hoped that with the careful following of cases now being undertaken at the various nerve injury centers still more exact estimates and further information about the variables which affect the rate of nervous regeneration will be obtained. This should help considerably in the diagnosis, prognosis and management of these cases in which the long delay before recovery is such a difficult feature.

Hyperhidrosis of the Feet. **R. G. Park.**

Arch. Dermat. & Syphilol. **48**:539 (Nov.) 1943 (Correspondence).

In the issue of the ARCHIVES for June, 1943, there appears a paper under the title "Symmetric Lividity of the Soles," by Captain L. M. Nelson. The eruption described corresponds so closely to one of the commonest dermatoses affecting servicemen in the Middle East that I am impelled to add some remarks on our experience with it over the last three years. The great frequency of the disease under military conditions is in striking contrast to the paucity of references to it in the literature.

The lividity (or erythema) referred to is only one of three main features of the eruption, the other two being excessive sweating and hyperkeratosis. Since sweating is the most constant manifestation, the dermatosis has usually been labeled "hyperhidrosis" or, more colloquially, "scalded feet."

Since, however, erythema or keratosis may occur without hyperhidrosis in some cases, it seems likely that none of the three features is primary and that all are effects of some underlying disease.

My colleagues and I use the following routine: twice daily antiseptic soaks, for which a warm solution of potassium permanganate (1:4,000) is the best preparation. The feet are soaked for ten to fifteen minutes and are allowed to dry thoroughly afterward. This should leave a brown tan on the skin; if not, it means that it is not being done correctly or that sweating is so profuse that it immediately washes the strain off the

skin. The feet and socks are then well dusted with 3 per cent salicylic acid in talc.

This controls the disease in the usual forms. The milder forms may be relieved by use of:

Methenamine, 0.5 Gm.; Tragacanth, 0.05 Gm.; Talc, 25.0 Gm.; Water, 74.0 Gm.

This makes a creamy lotion which is easy to spread over the feet and leaves a liberal residue of powder on drying. Action of the acid sweat on the methenamine liberates formaldehyde, which inhibits bacterial growth and hardens the skin, preventing maceration.

The Rehabilitation of Heart Patients. Basil Parsons-Smith.

Brit. M. J. **2**:298 (Aug. 18) 1943.

As soon as the urgent symptoms have subsided, a course of light general massage, with passive and later active resistance movements at the larger joints, should be begun.

Remedial measures include massage, graduated exercise, electrical treatment and recreational activities. Generally they may be permitted to resume such forms of exercise as they followed before their illnesses and such games and amusements as are in keeping with their age, physique and personal inclinations. Certain principles are fundamental to the question of exercise and recreation in recovered heart patients: 1. They must not involve extensive muscle-group exertion, either sudden or prolonged. 2. They must not admit of undue exposure to weather extremes or tests of endurance. 3. They must be regulated according to the exercise tolerance of each individual patient, which can be ascertained partly by objective examination, partly also by the patient's own description of his effort sensations.

Apparatus for Buerger's Exercises. Ira M. Gambill, and Alan Kamenshine.

M. Bull. Vet. Admin. **20**:173 Oct.) 1943.

An apparatus which was constructed at the Veterans Administration Facility Mountain Home, Tenn., to administer Buerger's exercises in the treatment of peripheral vascular conditions of the lower extremities, has given particularly satisfactory service. In use for eight months up to July 1, 1943, it has proved superior to other means of administering those exercises. This includes the modified Buerger-Allen technic.

The outstanding features of this apparatus are simplicity of construction, ease of operation and adaptability for treating incapacitated as well as physically able patients. Since with it one can treat both legs simultaneously, the total period of treatment is thus lessened, with conservation both of the patient's energy and the time of the technician. The incapacitated patient can, by the technician's aid, be given the exercises with no effort on his part.

The leg is elevated for a minimal time to produce blanching of the foot, which may take from one-half to three minutes; the foot is then allowed to hang down from one to two minutes beyond the time required for maximum redness (if this produces pain, the period is to be shortened); and the leg is next rested in the horizontal position for three to five minutes. These three movements constitute a cycle that is to be repeated about half a dozen times during one treatment session, which should occupy about an hour.

Acceleration of co-ordinated Muscular Effort by Nicotinamide. I. M. Frankau.

Brit. M. J. **4323**:601 (Nov. 13) 1943.

The report summarizes the results obtained from a series of experiments undertaken to demonstrate by means of a selected test the effect, if any, of certain vitamins on the physical efficiency and the fatigability of healthy young adults.

It has been shown in a series of carefully controlled experiments that the addition of nicotinamide alone, or of nicotinamide and certain other vitamins, to the diet of fit young men results in increased efficiency in carrying out a fairly severe test involving both physical effort and coordination.

The test chosen was severe and called for the utmost cooperation from the subject, whose condition at the end of the test was just short of distress, as evidenced by his breathing and pulse rate. In earlier experiments the subjects appeared to be less exhausted after the administration of vitamins. Later experiments appear to indicate that continued heavy or exhausting physical stress may necessitate increasing the dose of nicotinamide.

Treatment of Lupus Vulgaris. F. Glyn-Hughes.

Brit. M. J. **4323**:495 (Oct. 16) 1943 (Correspondence).

Your annotation on the treatment of lupus vulgaris (Sept. 18, p. 366) is timely and prompts me to comment on what you no doubt are correct in labelling "a national disgrace."

The City of Liverpool can claim exemption from this stigma. There has been in Liverpool for the past nine years a lupus clinic which will bear comparison with any in this country. Our Finsen-Lomholtz lamps do not require the whole-time attention of a nurse.

The results of the treatment, particularly in the early cases, were so excellent that I conducted research in the haematology of the disease during treatment.

It should be said that the vast majority of cases have been either cured or sufficiently relieved to perform useful work. As your annotator points out, the treatment is long and expensive, but its success in the absence of active lesions in the chest (11 per cent in our cases) is so probable that it is well worth while. Local authorities in the surrounding area have made use of the clinic.